



The Alberta Journal of Educational Research

Vol. XII, No. 3

September, 1966

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COMMITTEE ON EDUCATIONAL RESEARCH
The University of Alberta

In Recognition and Commemoration

The Director, Division of Educational Research Services, the Editor, Alberta Journal of Educational Research and their associates past and present wish to pay a tribute to the memory of the late George Murry Dunlop.



During his long association with these enterprises he did more than any other to advance the conduct and dissemination of research. Without his initiative and effort neither the Division nor the Journal would have enjoyed the success that has typified them. His untimely death on July 12, was a shock and a grave loss.

To his wife, son and grandchildren we extend sincere sympathy.

Editorial Comment

This issue is experimental in three senses. In the first sense it is an attempt to gauge the reaction of our readers to the idea of the occasional issue of numbers devoted to a single topic. Others are tentatively planned and advance notice of the possibility of an issue devoted solely to research and comment on the work of Jean Piaget has been given. If the reaction of our readers is favourable to the idea and if sufficient suitable manuscripts are made available the number will appear next year.

The second sense of experimentality is concerned with the content. The manuscripts published herein are theoretical rather than directly empirical. Because journals devoted to educational research do not usually publish such manuscripts, your editor is anxious to determine the reaction of readers—particularly of those who are actively engaged in some aspect of research. It is hoped that they will see the relationship between the theoretical issues raised and the conducting of research. This relationship may not be as obvious or as significant as the editor believes but there may be many who will wish to either support or contest it. If this be so it is hoped that the pages that have been reserved in a future issue for comment and discussion will not have to be deleted for the want of sufficient copy.

The third sense is probably the most important. The symposium papers exemplify mature intellectual controversy with respect to the nature, role and value of models. Controversy of this type is not, and has not been, typical of professional journals in educational research or, in fact, in education generally. It is a characteristic of the journals devoted to the older and more mature disciplines and its encouragement in education is necessary if close and detailed scrutiny of ideas and suggestions about the conduct of the educational endeavour is to be achieved. It might even be argued that the level of discussion and criticism of views within a field can be taken as one criterion for determining the validity of the claim to be classified among the recognized disciplines.

When the decision to produce this issue in this form was taken it was believed that a set of manuscripts additional to the symposium papers could be obtained to directly relate the symposium content to research. Also the hope was that more extensive revision of the symposium papers would be possible than has in fact been the case. For these reasons the issue falls short of the objective originally set. However, in spite of these shortcomings, the issue possesses a character

significantly different from that of the past and more usual issues. This may or may not be considered meritorious by all readers.

In their article *An Analysis of the Use of Models in Education*, D. A. MacIver and E. A. Holdaway have attempted to describe, criticize and evaluate the many views about models that have been advanced in the natural and social sciences as well as in education. Their contribution provides, as far as is possible in a journal article, the background necessary for the consideration of the views expressed by Marc Belth and his associates in the symposium. They also provide sufficient detail to facilitate understanding of the nature and significance of the conflict among the symposium participants.

In the concluding article E. S. and G. S. Maccia demonstrate the utility value that can be obtained when a theory that has been established in one field is used as a model for a possible theory in another. Their contribution is somewhat concentrated and for this reason its significance may not be as readily noticeable as might be desirable. However, their treatment of the topic demonstrates the significance and nature of the difference between the use of a model to suggest possible theories and interpretations and the more risky use of examples as analogies which is advanced by Marc Belth.

The "Sociologist's Response" by Dr. Ronald G. Jones could not, owing to the author's summer engagement in Europe, be prepared in time for inclusion in this issue. This is a series omission which is regretted and the deficiency will be repaired as far as reparation is possible by including it in the next issue.

The editor wishes to express thanks to the contributors and to the office bearers of the Western Canadian Conference on Educational Foundations for making the papers available for publication in this issue. Thanks are also extended to D. A. MacIver, E. A. Holdaway and the Maccia's for preparing manuscripts specially for this issue.

This article presents an analysis and interpretation of common uses of the term "model". The discussion is at first general and then the specific area of educational theory is considered prior to explication of particular educational theory models. The direct implications of models for research design are evident and important.

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An Analysis of the Use of Models in Education

Introduction

In recent years, models of various types have been described in the social science literature, and some used as starting points for empirical studies in education. For example, Getzel's model of the nomothetic and ideographic dimensions of social behaviour, and subsequent developments of this model, has been the source of many hypotheses in educational administration. However, use of the term "model" has become commonplace, resulting in a multitude of meanings which can be confusing to the student, practitioner and researcher. In this paper, an attempt is made to clarify the various meanings, and a rationale is developed for a more thorough examination of the uses of models.

The sequence of this development is as follows. Initially, the ways in which "model" is used by various authors are reviewed, and a classification of the major types of models is presented. The values of the different types of models are explained, and the various cautions in the uses of models listed.

An examination is made of the branching classification of models presented by Elizabeth Maccia in 1962, with emphasis on the use of non-representational models of General Systems Theory and pharmacogenetics. Some of the models used in the study of educational administration are analyzed in the light of the various classifications.

Throughout this paper, many examples of models are presented from the physical sciences. This is due to the earlier and more extensive use of models in that area.

I—Uses and Classifications of Models

Brodbeck, Griffiths, Kaplan and Maccia all comment on the ambiguous, common and incorrect uses of the term "model". One of the more common misuses is as a synonym for "theory". Brodbeck gives two reasons why this may be so, first because the uncertainty, selection, idealization and quantification of models are also characteristic of theories, and because models of the ideal state are theories. Kaplan thinks that theories are often spoken of as models, because of the importance of analogy in formulating the theory, and because of the essential role they continue to play in the theory. To demonstrate this he uses the example of the continued employment of the term "current" in electricity following the analogy of the flow of electricity in a conductor to the flow of water in a channel. In the social sciences, the term "model" is generally applied to various verbal and symbolic systems.

Hesse feels that "model" is a paradoxical term since the implication is of a literal and not a metaphorical description: such a model would not require an "as if" clause, but the "as if" clause reminds us of the possibility of a false description. The Newtonian Law of Gravitation is still a model, despite its considerable predictive power, because the "as-if-ness" is retained, that is, the heavenly bodies act *as if* the gravitational force between two bodies is inversely proportional to the square of the distance between the bodies.

Rapoport discusses Mendel's "mathematical theory of the segregation and recombination of distinct inheritable traits," and states that Mendel considered that "it was *as if* the character traits were attached to independent carriers transmitted intact from generation to generation."¹ The model's force lay in its predictive power, which led to statistical relations concerning the frequencies of transmission of certain characteristics from one generation to another.

The use of "model" was initiated, according to Knezevich, "because a theory could be conceived as an attempt to develop a picture or pattern of events." He sees a model as representing "a type or form of expression of the fertile assumptions of a theory," and elaborates:

The description of events and their relationships are part of a model that attempts to predict what will happen in the real world. The model, as well as the theory, is a symbolic expression of the theorist's conceptual framework in a given area. "Building a model" means much the same as "constructing a theory."²

Various types of models are identified and classified in the literature. Confusion often arises because the means of defining the model are not consistent. It appears, however, that most writers use operational definitions which means that writers may define the same model in different ways. The definition depends upon the way in which the model is to

be used rather than upon any intrinsic features of the model itself. In this explication an effort is made to draw attention to the distinction between real definitions and operational or programmatic definitions. The following list is an initial classification of the various uses of models: the preferred terms are placed in block capitals.

1. A MODEL DESIGN (Black)
2. A NORMATIVE MODEL, or *Exemplar* (Black)
3. A SCALE MODEL (Black), or *Physical Model* (Kaplan), or *Object Model* (Maccia)
4. AN ANALOGUE MODEL (Black), or *Representational Model* (Maccia), or "Model Of" (Brodbeck) or *Semantical Model* (Kaplan), or *First Order Model* (Maccia), or *Substantive Analogy* (Nagel), or *Conceptual Model* (Downey)
5. A THEORETICAL MODEL (Black), or NON-REPRESENTATIONAL MODEL (Maccia), or "Model for" (Brodbeck), or *Interpretive Model* (Kaplan), or *Second Order Model* (Maccia).

Scale Models

Scale models are defined by Black as "all likenesses of material objects, systems, or processes, whether real or imaginary, that preserve relative proportions."³ Kaplan calls these "physical models", and refers to them as the "oldest and most widely used type of isomorph . . ."⁴ He attributes to them the advantages of accessibility, manipulability and feasible experimentation, with the comment that they can be used to assess theories, a use which is leading to gradual recognition of their importance in the behavioural sciences, as is seen in computer simulation of personality. Brodbeck refers to a scale model as a "non-verbal description", remarking that these replicas do not yield new knowledge, but show isomorphism which requires fulfillment of the following conditions.

- (i) A one-to-one correspondence between elements of the thing and the model, i.e., all items are reproduced.
- (ii) The elements are in the same position.
- (iii) The model is constructed to scale.

Complete isomorphism exists between a scale model (either mini-fied or magnified) and the original, when relative proportions are preserved and when both the model and original operate in the same manner—for example a model steam train run by steam. *Incomplete isomorphism* is seen in a planetarium representation of the heavens, in which the motions of the planet models across the hemispherical ceiling are not caused by gravitational attraction, as we believe the motions of the planets to be. These simple concepts are important because they

enable the educational theorist to be aware of the simplicity of the foundations upon which the more complex models are based.

Analogue Models

Analogue models form a different class of models, and are seen by Black to involve a change of medium. He defines an analogue model as "... some material object, system, or process designed to reproduce as faithfully as possible in some new medium the *structure* or web of relationships in an original." Therefore, whereas scale models imitate the original, analogue models reproduce the structure of the original; "thus, the dominating principle of the analogue model is what mathematicians call 'isomorphism'."⁵ Kaplan uses the term "semantical model" to refer to a "symbolic or conceptual analogue."

The following quotation shows that Hesse uses "analogy" in the same manner as does Black.

The most obvious property of a satisfactory model is that it exhibits an analogy with the phenomena to be explained, that is, that there is some identity of structure between the model and the phenomena.⁶

For example, billiard-ball-like particles can be used as models for the postulated entities of gas molecules. Models can be generalized, extended, tested or modified, whereas formal deductive systems cannot be so manipulated. For example, the dynamical theory of gases leads to other questions which can be answered, one such question being, "Are gas molecules like rigid balls or elastic ones?"

Analogies are broadly classified by Nagel into substantive and formal types. Substantive analogies are described as follows:

... a system of elements possessing certain already familiar properties, assumed to be related in known ways as stated in a set of laws for the system is taken as a model for the construction of a theory for some second system.⁷

An example of a substantive analogy is the use of billiard balls or elastic spheres as being representative of the molecules of gases whose behaviour is described in the kinetic theory. The "system of elements" in this case is the set of billiard balls, whose elastic properties are familiar, and certain laws such as conservation of momentum can be ideally applied to their collisions.

Elizabeth Maccia describes a "representational model", or "model of" as one in which the object, or characterization of an object, is a model of what is represented.⁸ This seems to broadly agree with Black's "analogue model".

A "formal analogy" is defined by Nagel as existing when "... the system that serves as the model for constructing a theory is some familiar structure of abstract relations ..."⁹ Maxwell used the example of the

identity of structure of the mathematics of gravitation theory and those of heat conduction. The "formal analogy" of Nagel appears to be equivalent to the "formal model" of Maccia. Some of the confusion can be partly attributed to conflicting, but correct, uses of "analogy". Nagel uses "analogy" as in "substantive analogy" to refer to the analogue model of Black. Kaplan employs "analogy" when referring to scale models (physical isomorphs) and also to analogue models (conceptual isomorphs). Maccia subsumes scale models ("objects") under both representational and non-representational models, and also introduces characterization models under both classes.

The use of "model" as a synonym for "theory" has been seen by Brodbeck to occur when the theories have some or all of the following characteristics: (1) the theories are untested or untestable, (2) the theories involve abstraction, as in the "ideal type", (3) the theories involve abstraction, as for example when the theories refer to the physically impossible ideas of perfect gases or instantaneous velocities, and (4) numbers are attached to the concepts of a theory, thereby quantifying it.

Models have been defined as "scientific metaphors" when they, as theories, "... explicitly direct attention to certain resemblances between the theoretical entities and the real subject-matter."¹⁰ Kaplan states that analogies have been recognized as being essential to theories, and not merely important for theory formulation.

Kaplan talks of "formal models" as models which deliberately omit some essential variables, and therefore "... free our theory from the irrelevancies necessarily involved in any concrete embodiment of the structure."¹¹ In Hesse's view, scientists do not now assert that *perfect analogies* exist between models and the world, but only that *positive analogies* exist, that is, analogies in certain respects: "There may seem to be little point in talking about 'models' at all unless there is some respect in which the analogy they exhibit breaks down"¹² The *negative analogy* refers to the respects in which the model and the thing they represent are not alike.

Theoretical Models

The term "theoretical model" encompasses a class of models different from those subsumed under "analogue model", and appears to indicate the purpose to which the model is put. Brodbeck points out that an unambiguous meaning of the term model, useful in theory formation, is provided in this postulation: "If the laws of one theory have the same form as the laws of another theory, then one may be said to be a *model for the other*."¹³ Isomorphic or structurally similar theories are those which have laws of the same form.

George feels that it is essential to distinguish "... between a model for a theory and the theory itself," and he compares a model to a skeleton, whereas the relevant theory can be compared to a complete organism.¹⁴ Kaplan uses the term "interpretive model" for theoretical model, describing it as "... a concrete instance of the abstract form ... which allows us to use what we know of one subject matter to arrive at hypotheses concerning another subject matter structurally similar to the first."¹⁵

Maccia's other major category of models, the non-representational model, is recognized in having the object or characterization as a "model for" whatever it is represented in, and this term is therefore seen to be equivalent to "theoretical model."

The theoretical model need only be described and not built, according to Black, who lists the following as conditions for the use of a theoretical model.¹⁶

(1) An original field of investigation is needed in which some facts and relationships have already been established.

(2) A need is felt for further scientific investigation of the original field.

(3) Some entities belonging to one domain are described in suitable detail.

(4) Rules of correlation are available for translating secondary field statements into original field statements.

(5) Inferences from the secondary field assumptions are translated and checked against data in the primary domain.

A test for isomorphism of two theories is given by Brodbeck. Descriptive terms of one theory (the "model") are put into a one-to-one correspondence with those of a less-well-known theory, and the concepts of the better-known theory are then replaced by concepts of the less-well-known theory, forming hypotheses. If the hypothesis are shown to be true, then the two theories are *completely isomorphic*. If we wish to determine whether rumours spread in the same way as diseases, we could attempt to determine whether the laws of rumours have the same form as the laws of diseases. Alternatively, the manner in which diseases are known to spread, may provide investigators with clues concerning useful potential areas of enquiry, and this conforms with Brodbeck's notion of "model."

... when an area about which we already know a good deal is used to suggest laws for an area about which little is known, then the familiar area providing the form of the laws may be called a model for the new area.¹⁷

Either law can be considered as a model for the other if both are shown to share a common structure. Many speculative guesses about isomorphism occur in the social sciences, for example, the discredited notion that "society" can be likened to a plant with a seasonal life cycle, or to man's growth and physiology. Brodbeck claims that two steps must be taken to test these guesses to determine whether they can actually serve as models: (1) it must be possible to clearly state what things are in a one-to-one correspondence, and (2) formal similarities between the clearly defined empirical concepts must be sought.

If the model proves to be effective in an empirical sense and the laws of the two areas are symmetrical, then the term "model" becomes redundant. The theory which was discovered to be a theory by means of a model, becomes a theory in its own right and it is no longer necessary to use the term "model." Brodbeck concludes this discussion with a worthwhile reminder: "If very little is known about either field, then to speak of a 'model' is hardly more than loose and pointless talk."¹⁸

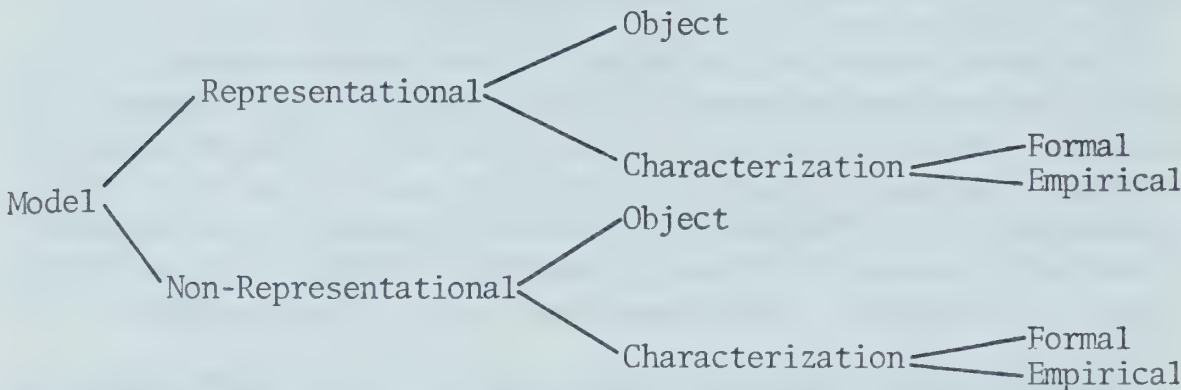
Brodbeck also sees no intelligible meaning of "model" in the following three types of connection: (1) between two theories about apparently different phenomena leading to the identification of one area with the other, (2) empirical cross-connection laws between two areas such as psychology and physiology, and (3) by definition between two theories so that one can be reduced to the other, for example, reduction of sociology to psychology. She lists three conditions as necessary to justify that concepts of one area obey laws of the same structure and refer to the same kind of phenomena as another area, namely, (1) structural isomorphisms, (2) the same constants in the laws of both theories, and (3) the applicability of the same descriptive terms to phenomena described by both theories: Maxwell met these conditions when he showed that light and electricity are similar. In investigating possible isomorphism between the mind and brain, it is possible that the laws of psychology and neuro-physiology may have the same form; however, the terms which are applicable to psychology are not appropriate for description of the physical-chemical behaviour of neurones, and therefore these laws are not connected because they do not satisfy the third condition listed above. The reduction of sociology to psychology has nothing to do with isomorphism or with one being a model for the other.¹⁹

Downey states that a conceptual model differs from a theoretical model may be suggested by the interrelatedness of phenomena and not necessarily by knowledge in another field; an effective conceptual model orders elements in a real system and assumes relationships among the elements.²⁰ Thus it would seem that a conceptual model is a "model of" a conceptual system or of some part of a conceptual system, i.e. if one believes that secondary education has a particular structure, one can

make a diagram of that structure which shows the entities and suggests relationships among the entities. This then is a “model of” an individual’s concept, but it can be used as a “model for” discussing and placing in perspective certain aspects of secondary education.

II—A Further Explication

Elizabeth Maccia, in 1962, presented the following branching classification of models.



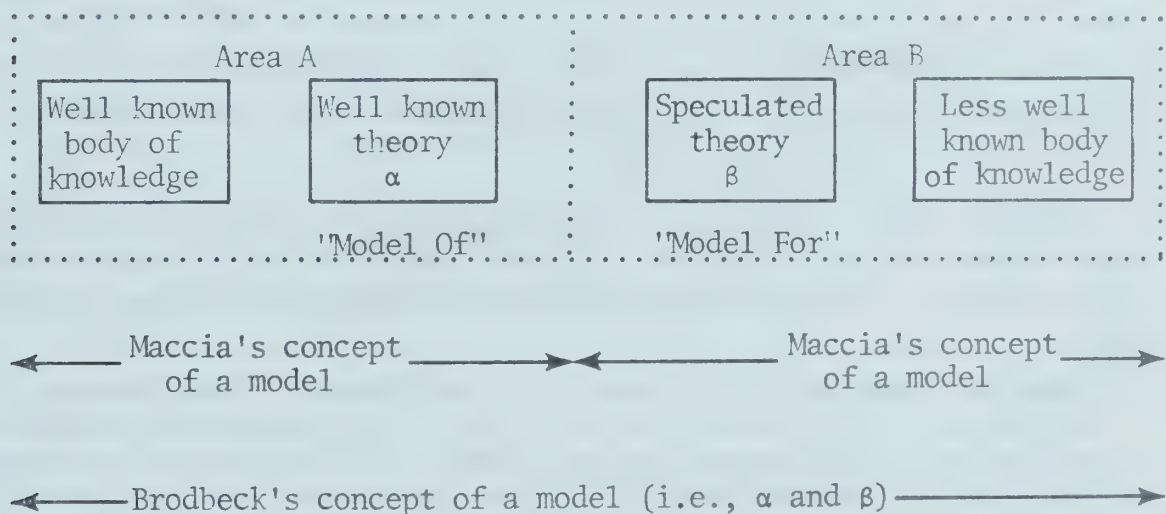
Her own definitions of these terms are often obscure: however, the following list seems to give the intended interpretations.

1. A *representational model* is a model of something, and is therefore equivalent to an analogue model.
2. A *non-representational model* is a model for something, and is therefore equivalent to a theoretical model. [This is considered to be an unfortunate term as the model does represent something: what it does represent is however not as important in this context as the field in which it is to be used.]
3. An *object model*, or scale model, is the term used when an object is used as a model. For example, a tape recording of a voice may be a (representational) object model for language pronunciation.
4. A *characterization model* is the term employed when an object is characterized, as usually occurs, and is not itself used. For example, the spreading of a disease is characterized in the theory of the spreading of diseases.
5. An *empirical model*: one empirical theory is used as a “model of” or “model for” another empirical theory. For example, the theory of the spread of diseases is used as a model for the generation of hypotheses related to the spread of rumours. The theorist is here concerned with both the content and structure of the theory model.
6. A *formal model* is a logical or mathematical representation of a theory which is used as a “model of” or “model for” an empirical

theory. The theorist is only concerned with the structure of the theory model, and not with its empirical content.

Although a variety of model types has been used in education for centuries, apparently it is only since 1962 that an effort has been made to construct models which can be used to test educational theories. In *Construction of Educational Theory Models*, Maccia *et al.* propose a series of models which may be used to develop educational theory; these models reveal, in retrospect, the fact that they are harbingers—there are greater things to come, but before anything does come from these models some analysis is necessary. It is evident that Elizabeth Maccia agrees with this view and that she is aware of the kind of criticism that will be made of her work. Such criticism is necessary if progress is to be made.

The main difference between Maccia's and Brodbeck's concepts can now be revealed fairly easily. Schematically, the differences are described below.



At this empirical level, Maccia is ready to use “theory” as equivalent to “model.” In area A (α) is a “model of” some body of knowledge, but it is also the theory of that body of knowledge; Maccia calls it a representational model. But Brodbeck would not apply the epithet “model” until the “model of” (α) becomes a “model for” (β) a less well known theory in area B. In Maccia’s terminology “model” and “theory” (i.e., α and β) may well be synonymous terms, a situation which Brodbeck deplores since it only serves to complicate an already overly complex situation.

This analysis should not be interpreted to mean that the terms “representational” and “non-representational” are superfluous expressions since there are significant reasons for giving models such labels as “representational” and “non-representational” in order to be aware of the particular function that is being performed by a model at any given time.

However, Brodbeck's definition of model involves the use of the model as representational and as non-representational, and if both functions are not performed by the model the term "theory" can be substituted. Maccia seems ready to accept the equivalence of theory and model.

III—Cautions in the Use of Models

In any discussion of the value of models, the cautions and dangers inherent in their use should be borne in mind. Nagel feels that:

... some inessential features of a model (especially a substantive model) may be mistakenly assumed to constitute an indispensable feature of the theory embedded in it; and the model may be confused with the theory itself.²⁰

He gives the example of the delay caused in discovery of the periodicity of light (its wave-like properties) by use of the emission theory of light in which an analogy was drawn between light and straight-line projectiles. Kaplan agrees with this criticism. Nevertheless, we cannot predict whether the use of a model will hinder the development of a theory, since the model must generally be tried before the value of the approaches to enquiry which it suggests can be assessed. But such limitations can be recognized by exploiting numerous "models for" a particular area of knowledge as Maccia does in her work.

Shapere raises the question as to whether the explanations of the type offered by Bohr's planetary atomic model are really explanatory, and proposes this view, although he feels that it may not be completely fair.

Are models even essential elements of a scientific theory? Some thinkers, notably Duhem, have maintained that models have only a psychological function in science: they serve as mental crutches for feeble [sic] minds trying to visualize the point of mathematical formulas, which are the essence of scientific theories.²¹

Kaplan deals with a different aspect. He lists the methods of the schools of behavioural science as experimentation, measurement, statistics, theorizing, and model building, with each school of thought seeing the other methods as complementary to its own main purpose or method.

Model building, though in some quarters it is still of questionable standing, is posing more and more of a challenge to the scientific Establishment in the study of man . . . When one doctrine, method, or technique comes to be regarded as the sole repository of truth, or the one avenue to truth, for my part I have no doubt that it is truth which suffers. The danger is all the greater with respect to model building because so much else in our culture conspires to make of it the glass of fashion and the mould of form. Models seem particularly appropriate to a brave new world of computers, automation and space technology . . . Scientific caution, if not ordinary prudence, seems to me to be very much called for.²²

In taking this stand, Kaplan is not decrying the use of models, but he is objecting to the "blanket condemnation and the indiscriminate en-

thusiasm that are evoked by models," and pleads for a scientific assessment of their uses and values, stating that one of the functions of philosophy is the critical examination of fashions. He lists the following as pitfalls to be avoided: (1) *overemphasis on symbols*, because of some "unconscious belief in the magic of symbols"—models such as $y = f(x)$ only tell us what we already know; (2) *overemphasis on form*, because "building a model, in short, may crystallize our thoughts at a stage when they are much better left in solution, to allow new compounds to precipitate;" (3) *oversimplification* of the wrong elements; (4) *overemphasis on rigour*, the necessity of which is denied by the great contributions of Faraday by means of common arithmetic; and (5) *map reading*, or failure to realize that not all the features of a model correspond to characteristics of the subject matter.²³

Another caution is listed by Brodbeck.

It is all too easy to overestimate the significance of structural isomorphisms. The fact that all or some of the laws of one area have the same form as those of another need not signify anything whatsoever about any connection between the two areas.²⁴

Braithwaite analyses the use of models in the empirical sciences and concludes, with Duhem, that the model does not serve a necessary purpose. But Braithwaite is considering the "empirical sciences," and it is doubtful if his criticisms extend to educational theorizing of, for example, the kind suggested by Elizabeth Maccia.

In his analysis, Braithwaite argues that models provide four types of predictive novelty, but he disclaims any value in the first two. The third and fourth types of predictive novelty are "arguments by analogy." But:

This claim cannot be allowed. Analogy can provide no more than suggestions of how the theory might be extended; and the history of science tells us that while some analogical suggestions have led to valuable extensions of the theory, others have led to dead ends.²⁵

This criticism has already been treated since, in educational theory, models are known to be tentative interpretations and should be continually compared with other interpretations.

IV—Conceptual Models

So far, most of the models discussed can be categorized as experimental models, i.e. specific theories can be developed from particularly constructed models, and these theories can be tested empirically. However, the conceptual model, which has already been referred to in this paper, falls into quite a different category.

Probably the extreme case for conceptual models is stated by Creegan who claims that human learning comprises constructs and reconstructs

of models of life and the world. He clearly believes that all learning is a matter of building and re-building models. Hempel seems to imply that all our explanations are modelistic in nature. We understand how things happen through the use of a particular type of model. Everything that requires an explanation commences in "wonder." There is an expectation, and if the expectation has not been satisfied a "wonder" is produced. Hempel suggests a hypothetical problem and proceeds to demonstrate how various individuals seek the same type of explanation, even though the degree of sophistication required is different in each case. Fundamentally each person asks the question, "I wonder why he did that?" The ordinary man is satisfied first, the social scientist is satisfied last, but the wonder refers to the fact that one view (model) of the universe is somehow incomplete. Once our wonder is satisfied our model is readjusted or the old model is reaffirmed. This is exactly Creegan's point, and it is also the point that Belth so thoroughly pursues.²⁶

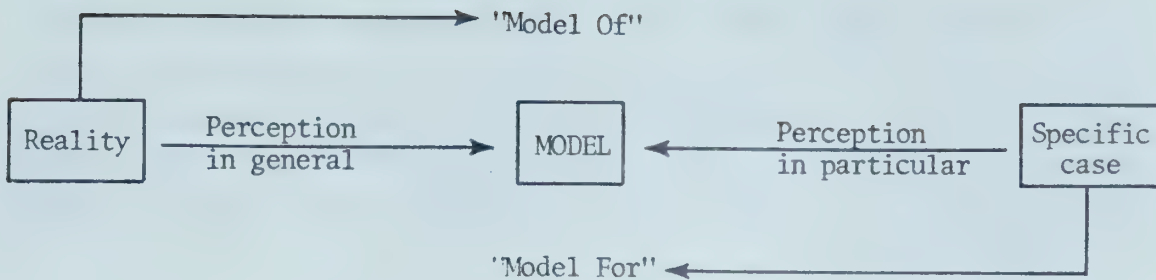
This modelistic hypothesis assumes that we never perceive reality, we only perceive models of reality. Our models are empirically tested throughout life and we keep adjusting our model until we have a fairly high degree of consistency between one model and the empirical facts. Creegan maintains that the essential feature of modelism is the recognition of an arbitrary feature, i.e. we continually test and evaluate, but always the testing and evaluating is done from some kind of given framework. Hence, there is always an arbitrary element in anything which we do, and this arbitrary element is the model which enables us to understand the world.²⁷

When the term "conceptual model" is used in this sense one immediately gets the feeling of the "holistic" view and of the gestalt function of the model. But the term "model" when so used must surely be synonymous with "schema." Each individual has a view of the world which is comprehensive and which enables him to make sense of reality.



This perceived model of reality is prior to any other kind of model and it seems reasonable to argue that this prior model is the template which establishes any succeeding model.* Hence:

*This view seems implicit in the works of the social psychologist Bernstein, who demonstrates that children from culturally deprived homes do poorly in academic work. Thus the sparse "models of" reality seem to transfer to specific areas of knowledge. The one model is the template of the other.²⁸



This approach to the perception of situations in general fits in well with Hempel's concept of scientific explanation, i.e. we derive all our knowledge from the common mass of data known to all men. But the scientist has a much more refined and productive view (model) of the world than the layman.

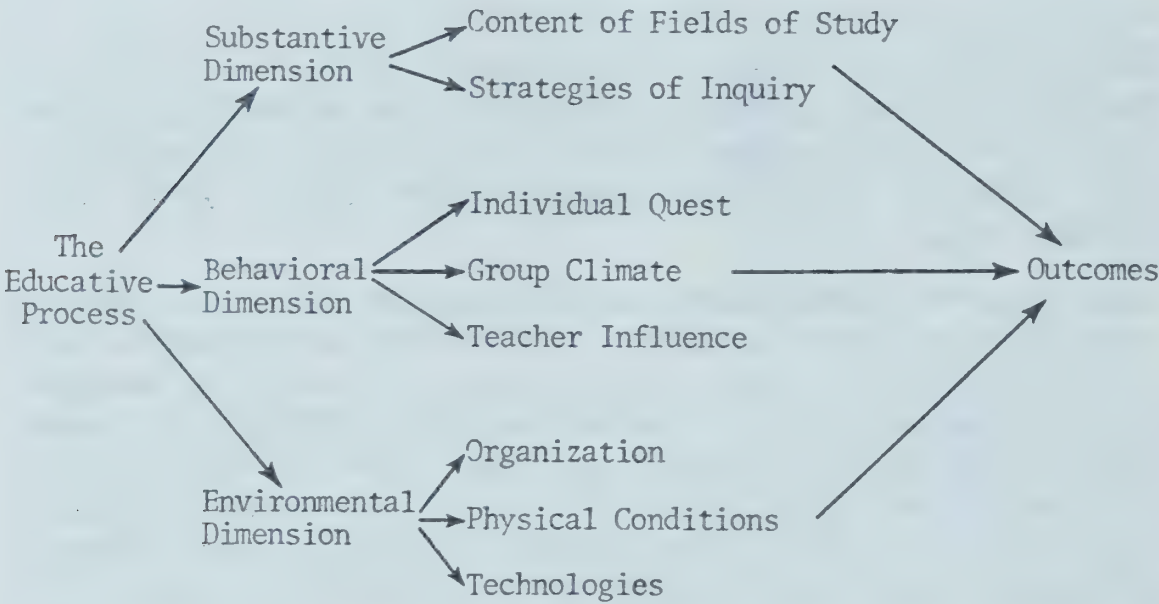
A "conceptual model" then is not only used to refer to one's general "view of reality," but it can also be used to refer to one's general view of a particular subject. Dewey used a conceptual model for education, but seemed aware that such a model was only to be used as a means of viewing the general process of education. This conceptual model is not an experimental model since it is a way of understanding and not a way of testing. Further, a conceptual model is not a theory, although any particular model may make explicit theories that are implicit.

However, the conceptual model precedes both the experimental model and the theory. Obviously in theory production one must have an understanding of the situation in general before one can formalize theories. The first thing then is to do as Scheffler did in his article "Philosophical Models of Teaching"; i.e., to make manifest the general knowledge and the conceptual model that organizes it. If this is done, the general area of teaching experiments can be viewed as a series of contributions that help to establish the holistic view of teaching. But the conceptual model must surely be considered and clarified first and any particular experiment must be perceived as part of the whole, otherwise the condition, which is so apparent in educational research, will remain haphazard and disoriented.

Briefly the argument over conceptual models to this point may be summarized: We have a generalized view of the world and we have general views of particular areas of knowledge within the world. The first model seems to be a sort of template for the second model. It is postulated that theory development starts with a conceptual model of some area of knowledge and that scientific knowledge is obtained through the use of experimental models and theories. However, until the experimental models and theories are tested, they are only theoretical advances upon the conceptual model. But, the conceptual model is prior, and the more comprehensive the model is, the more effective it is for ex-

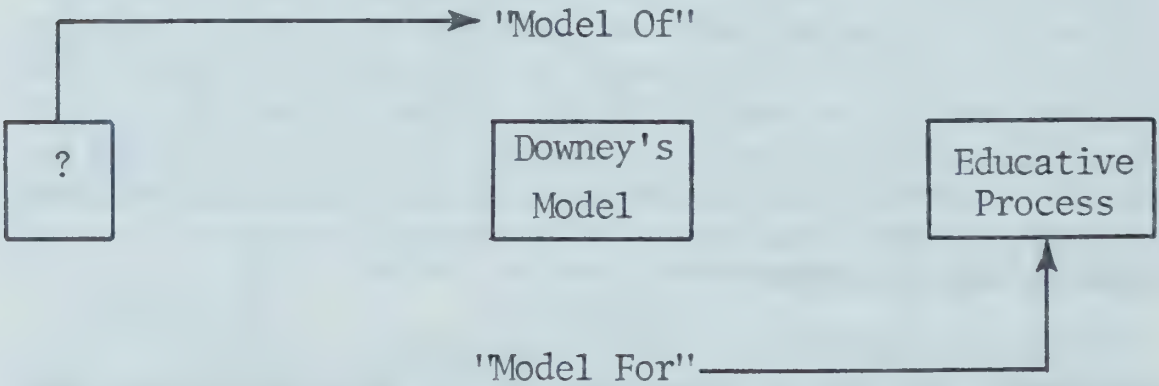
perimental purposes. It is speculated that much of the hit and miss in research today is due to the lack of comprehensive conceptual models.

In Downey's article "Secondary Education: A Model for Improvement," one finds a representational model of the characterization type. Its purpose is to demonstrate the value and need for theory in secondary education and to propose a method for developing one. Downey's model is illustrated below.²⁹



There is no doubt about this model being a gestalt, but there is doubt over the legitimacy of the use of the word 'model'. It is certainly a "model for" the "educative process." But what is it a "model of"?

Schematically this may be illustrated in this way.



If this model is compared with Brodbeck's "Complete Model," which was schematized earlier, it will be seen that Downey's theory is not a "model of" an identifiable body of knowledge but represents the dimensions which Downey considers to constitute secondary education. It is a "model for" the "Educative Process" and in this sense it is a model as far as Maccia is concerned. The introduction of the term "conceptual model" relieves the situation since the schema is obviously a "model of" Downey's concept of secondary education.

Downey's model enables us to get a "bird's eye" view of a complex process. But the writers consider that it is a conceptual model and not an experimental model; perhaps it is better described as a conceptual schema. And somewhere, within this scheme of things, experimental models will be constructed to test the knowledge of particular parts of the schema. But the schema is evidently prior, it is like a skeleton which can only be filled out by very specific procedures. And the procedures in this case are experiments which will confirm, reject or vary the schema.

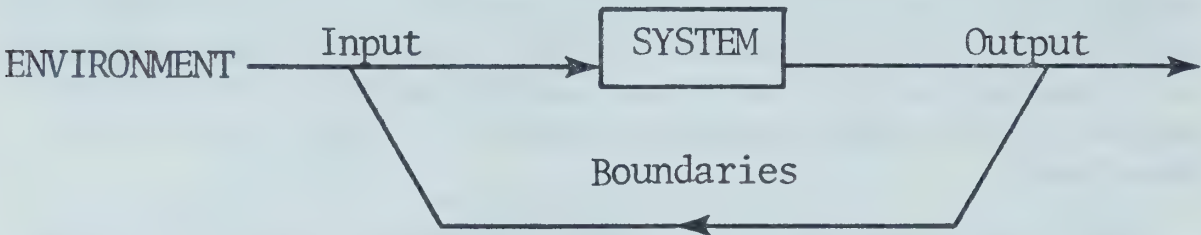
Three main problems appear with diagrammatic representation of this type. Having established the schema (especially if it is of the Downey type model), the impression obtained is that the schema is representative of a closed system. Education is obviously not a closed system, but it is very difficult to remain aware of this fact. Secondly, the entities named in a schema are liable to be considered as separate, isolated entities which at a certain recognized point in time combine to form a new compound after the fashion of chemical reactions. This is a category mistake since one is transferring concepts of physical entities to a different realm. For example, it is difficult to identify "individual quest," or "group climate," and it seems that one cannot define these terms without referring to other entities which are represented as independent entities in the schema. Thus, the entities which are schematized to give the impression of isolation are actually fluid and can only be properly understood in that fashion. A third problem as has previously been mentioned, is that if the schema is closed too soon, fruitful avenues of research may be inadvertently blocked off. When the diagrammatic construction is forced it is obvious that the theory developed may be misleading, so Kaplan advocates longer periods of gestation in most cases.

V—Discussion of Particular Educational Theory Models

General Systems Theory, proposed by von Bertalanffy, "is based on assumptions of non-linearity and complex interactions among the parts which make up the system."³⁰ It centres on total system behaviour, and therefore would appear to be suitable as a model for educational theorizing because of the interactions which occur between students themselves, between students and teachers, between teachers and administration, between the school and the community, and between people and the physical environment. It is an attempt to consider the system as a whole and by implication is critical of educational practices based on theories which assume linearity and additive relations between independent items. The wholeness of a system is neither esoteric nor mystical, even though the unity is not simply a sum of its parts. The parts, as atomistic contributions to a whole, are all open to the procedures

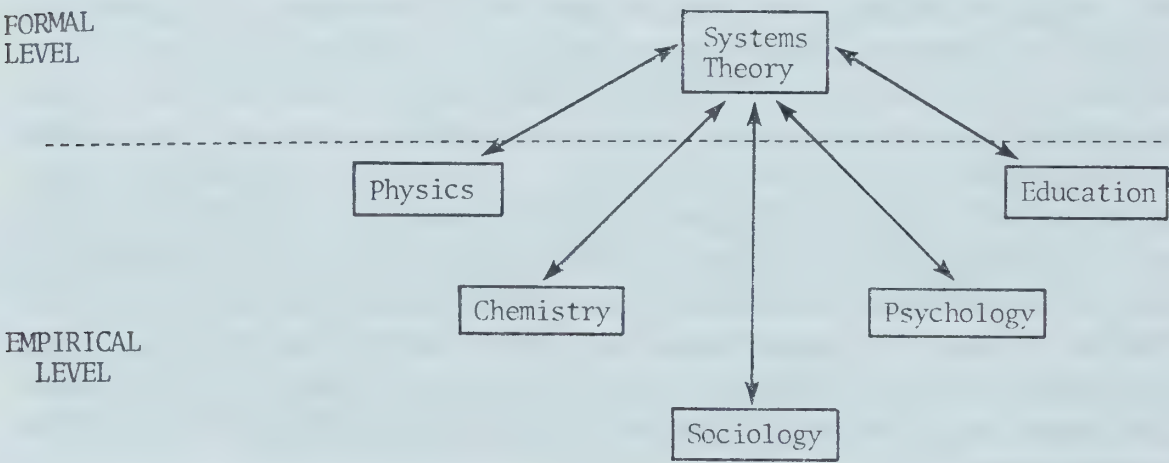
of empirical science, as are the interactions that operate among the parts.

The basic general systems model may be diagrammatically illustrated.



George Maccia considers the school to be the system and within it there is a variety of sub-systems. The complex diagram is illustrated and the input and output is tabulated in his work.

The model is a conceptual model rather than an experimental model, and is schematized in the following diagram, in which the use of a theory as a "model for" or a "model of" depends on the direction of the arrow.



George Maccia has evidently taken the systems model schema, but he has not developed things beyond this point. It is granted that he has identified the entities, but he does not demonstrate the laws which hold among the entities. It seems that the important feature of General Systems Theory is that:

There exist therefore *general systems laws* which apply to any system of a certain type, irrespective of the particular properties of the system or the elements involved. We may say also that there is a structural correspondence or logical homology of systems in which the entities concerned are of a wholly different nature. This is the reason why we find isomorphic laws in different fields.³¹

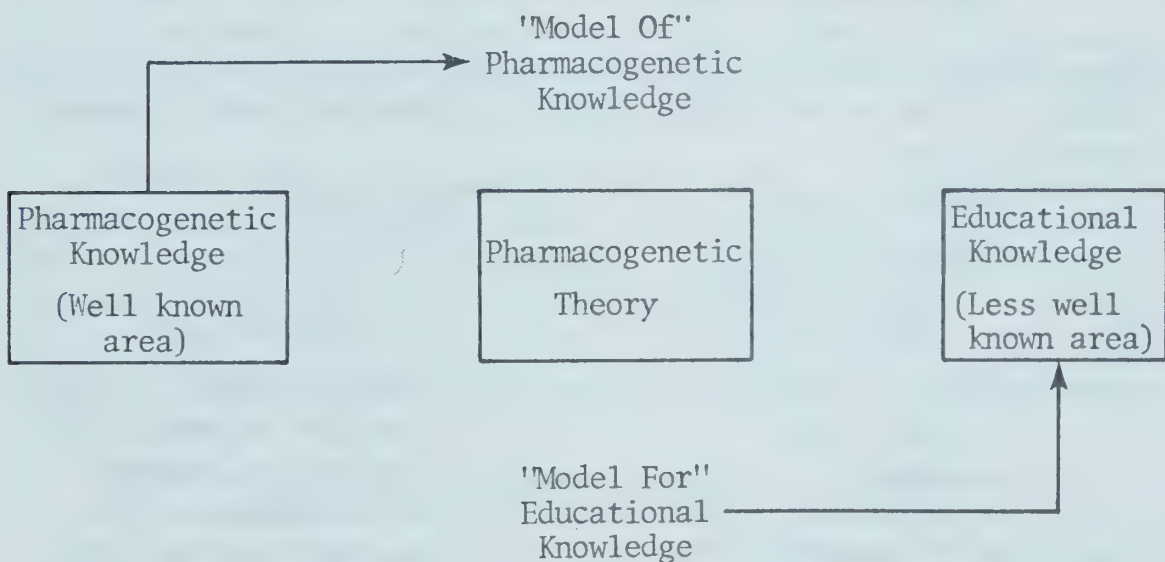
Maccia does not mention these laws yet a promising area was opened by him:

Environmental conditions greatly affect the rate of formation and reformation. Consider what happens in a system of schools. . . . Population growth of a community usually results in the growth of a school. If the growth in population is rapid and sustained, an existing school will increase in size resulting

in the building of additional schools. In areas where resources are insufficient for expansion, several schools may be destroyed and a large, consolidated school established. In communities where the school is a major economic, political, or social factor, the destruction of inadequate schools will occur at a very slow rate.³²

It is difficult to imagine that only a model could have given this information; any school superintendent is aware of these problems. Furthermore, any of these superintendents is aware of the general system into which his school fits; or, at least, he could be made aware of the fact very easily. Yet Maccia seems to go to unnecessary lengths to state these truisms: General Systems Theory is already a representational model into which specific situation terms can be substituted without establishing isomorphism.

An experimental model which fulfills all Brodbeck's requirements is the Pharmacology-Education model in *C. R. P. No. 1632*.³³ It represents the type of experimental model which is most common in educational theory, i.e. a representational model of the characterization type.



According to Maccia *et al.*, pharmacology refers to the effect of drugs on individuals; education refers to the effect of teaching on individuals. A mathematicized formula is used to demonstrate that the same quantities of identical drugs have differing impacts upon individuals. This, it is argued, is analagous to the differing teaching techniques which likewise have different results on the individual, but due to greater laboratory control, more is known about the difference in drug results than about the difference in teaching results. The differing results are not only due to the drug but to the physiological make-up of the subject. Hence, pharmacology and genetics combine and become pharmacogenetics. Pharmacogenetics is considered to be the well known area of knowledge and its theory is used as a "model for" a less well known area of knowledge—education.

A summary of the pharmacogenetic items that are developed for isomorphism follows:

1. The subject, i.e., the individual who undergoes the test.
 - a. The monofactorial influence—when the manifestation of particular characteristics depends upon possession of a single gene, e.g., like ability to taste.
 - b. The multifactorial influence—where manifestation of particular characteristics depends upon many genes, e.g., height—a characteristic that appears on a continuum.
2. The drug.
3. The drug effect to which the following isobolic descriptions apply:
 - a. Additive—drugs have no interactive impact upon each other.
 - b. Potentiation—drugs interact and increase the effect of each other on the subject.
 - c. Depotentiation—drugs interact and reduce the effect of each other on the subject.

These pharmacogenetic entities are then placed in an isomorphic relationship with an aspect of education that Maccia *et al.* term “pedagotypology.” Thus:

Pharmacogenetics

1. Subject
 - a. Monofactorial
 - b. Multifactorial
2. Drug
3. Isobolic impact
(of drug)
 - a. Additive
 - b. Potentiation
 - c. Depotentiation

Pedagotypology

1. Student
 - a. Monofactorial
 - b. Multifactorial
2. Subject Matter
3. Isobolic impact
(of subject matter)
 - a. Additive
 - b. Potentiation
 - c. Depotentiation

From this point, problems with the model start revealing themselves. The isomorphism has been structured without reference to what appears at first sight to be a significant relationship, i.e., the relationship between the drug giver and the teacher. The nature of the relationship, however, is difficult to work out. One gives the drug, the other gives the subject matter. But this isomorphism seems superficial except under unusual circumstances. The drug giver has very little influence upon the drug effect, but the teacher has an influence which varies according to the nature of his personality and his level of competency. These variables are hardly likely to apply to a competent technician whose work is limited to giving drugs and recording their effects. The drug giver could be replaced by mechanical devices, such as a machine to dole

out the drug and record the reaction of the drug (blood-pressure devices, etc. . . .). It seems that the isomorphism could be made significant in a limited area if the drug giving and recording machine were placed in an isomorphic relationship with a teaching machine capable of recording the results of its own teaching.

The result of such an isomorphism may be effective in identifying those elements involved that are either due to monofactorial or to multifactorial genetic structure in the student. If this is the case a means of developing a typology as desired by Maccia *et al.* is a distinct possibility.

The procedure would be complex. Large numbers of students would have to be subjected to the experimental programme so that the multifactorial and monofactorial features can be identified and calculated according to pharmacogenetic techniques. This will enable students to be "typed" not according to a continuum only, but according to both a continuum and a polarized scale.

Precisely the same approach may apply to the isobolic impact of the subject matter as applies to the isobolic impact of the drug. And, once more, the use of teaching machines could eliminate the purely personal idiosyncracies of human teachers.

But this isomorphism depends upon another isomorphism, i.e. the drug and the subject matter, and a close scrutiny may well reveal that such an isomorphism is non-existent. The reason for this impossibility of isomorphism rests in the entities concerned and in the ways of defining these entities. A drug can be defined by a *real* definition which can be intersubjectively accepted. But such is not the case with subject matter. Belth states:

Moreover, to say that the second element is subject matter only opens the door to further inquiry about the material which is to be taught and learned. How is this material created, or brought about? What are its beginnings and endings? . . . What tests demonstrate its pertinence, its traits, and its worth? In what sense is it to be considered and treated as material?³⁴

It seems that the best that can be done with the subject matter is to define it in a programmatic or stipulative fashion. Hence, on the one hand, there exists a clearly definable entity, and on the other hand a stipulatively defined entity. This has the advantage, from a purely heuristic point of view, that if the isomorphism does not work at first then a new definition of "subject matter" may make it work later. But such re-definition of the term "subject matter" simply means that the educational entity is being forced to fit the Procrustean bed of pharmacological theory.

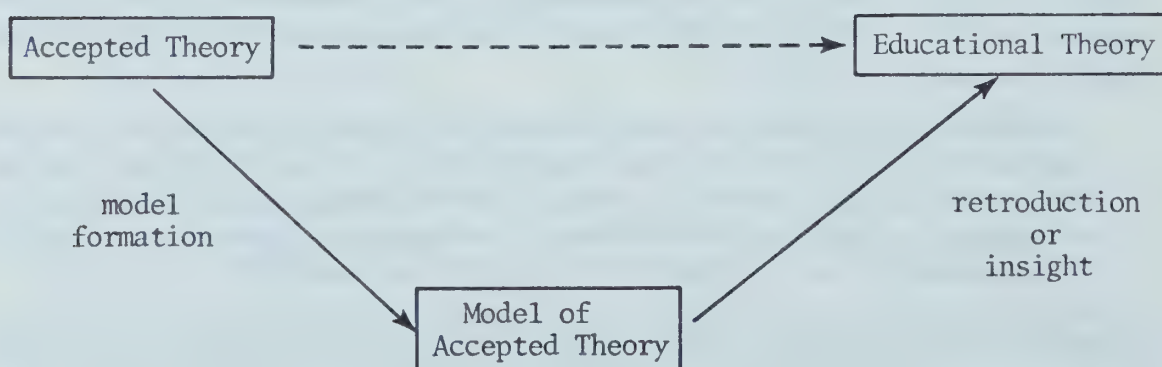
A series of criticisms has been implied in this analysis of Maccia's work, but the point that Maccia stresses is that she only desires to pro-

vide a new perspective from which to view the educational process. She provides this view and succeeds in suggesting new techniques to educational researchers. There is little fear of a model “crystallizing out” too soon, since each model will be compared and contrasted with other models so that inadequacies in any particular model may be revealed. However, one cannot help but be concerned over the obsession with a model that some writers have mentioned—models can be so beautiful that it is easy to love them.

VI—The Value of Theoretical Models

Elizabeth Maccia investigated the role that models play in theory formation by considering deduction, induction, reduction and retroduction. The characterizations or statements about objects are produced by retroduction (insight) and clarified and completed by deduction: induction is used to determine which objects fall within the range of the characterization.³⁵

An accepted theory can be instrumental in producing another theory, if the accepted theory provides concepts or means of relating concepts which can be used to characterize the objects under study. The approach through theory models is therefore not deductive, inductive or reductive, but is retroductive, as particular elements are arbitrarily selected from the accepted theory for inclusion in the new hypotheses. This diagram represents Maccia’s approach.



Retroduction and deduction are related to non-representational characterization models, both of the empirical and formal types. Non-representational models (“models for”) of the characterization type are significant for theorizing, that is, for the devising and explicating of educational theory, whereas representational models (“models of”) of the object and characterization types can evaluate educational theory. The following figure is an adaptation from *The Model in Theorizing and Research*.³⁶

A study of thirty-seven abstracts analyzed by Maccia showed that educational theory writings generally use "model" in the representational empirical sense. This is significant in evaluating theorizing, but in only

	Representational			Non-Representational		
	Object	Characterization		Object	Characterization	
		Empirical	Formal		Empirical	Formal
Retroduction (devising)					X	X
Deduction (explicating)					X	X
Induction (evaluating)	X	X	X			

three abstracts was the concept of model allied to evaluation. Maccia concluded that the prevailing conception of model is not related to the processes related to educational theorizing, but rather that the educational theory itself is seen as the model. This educational theory was generally conceived as a characterization model of educational phenomena. Although this approach is logically legitimate, Maccia sees it as sterile. The social sciences, natural sciences, logic and mathematics can be explored for devising models for educational theory. Although the natural sciences are the furthest from education, Maccia feels that they offer the most possibility for devising models useful in formulating educational theory. The social sciences can provide representational models, but both interdisciplinary and educational discipline approaches are needed. However, it cannot be predicted whether a theory from another discipline will help devise or explicate educational theory, or be used as educational theory.

She therefore sees the most desirable and fruitful approach for the development of educational theory as being through non-representational models of the empirical or formal characterization type, and mentions that this is being used by Ausbel, Carroll and Griffiths.

The importance of models in establishing the fundamental assumptions of a theory, as well as in extending the range of application of the theory, is also mentioned by Nagel. Griffiths says that adaptation of the models of other disciplines has been a source of the content of theory in non-educational administration fields.³⁷ A promising model is defined by Black as one with "... implications rich enough to suggest novel hypotheses and speculations in the primary field of investigation."³⁸ George mentions that models have sometimes been used descriptively, but we need models with theories of controlled vagueness, as the possibility of many interpretations of models is essential if science is to be fruitful.

However, the strong resistance frequently encountered by theories developed from unfamiliar models is seen by Nagel to continue until the strangeness of the novel ideas is lost—a new generation may accept, without question, a model rejected by a previous generation as unsatisfactory because of its unfamiliarity.

Jewett expresses the opinion that the agricultural economy is a much more fruitful model for the generation of educational theory than is the industrial economy, but it has been used much less frequently.³⁹ He provides examples of equivalent terms which may help the student, who is inexperienced in the application of exotic theories as models for educational theorizing, to better understand the procedure which can be followed. For example, plants and livestock can be considered as equivalent to pupils, food to course content, the farmer to the teacher, and production goals to educational purposes.

The agricultural subsistence economy model was considered by Jewett to be appropriate to theorizing about elementary education. For example, just as the subsistence farmer is known to have neither the facilities nor incentive to produce new types of livestock food, but must rely on outside agencies, so it may be that the elementary school teacher has neither the facilities nor incentive to produce new content, but must rely on the university and other centres. Similar hypotheses can be developed about university education based on the model of our knowledge about the agricultural market economy.

Some of the propositions derived from the agricultural theory are merely expressions of common sense but others have been supported in the literature, pointing to the significance of the agricultural economic theory in particular, and to this approach in general.

Newton's Laws of Motion provide another exotic field for the generation of hypotheses for educational theory. George Maccia and Reynolds proposed certain "laws" of teaching and learning based on Newton's Laws, and extended these into certain corollaries. For example, Newton's First Law of Motion is "translated" into "Every person persists in a state of behaviour unless compelled by an external influence to change that behaviour," and then into, "Every student persists in not learning unless influenced by a teacher to learn."⁴⁰ These obvious oversimplifications can be possibly reduced by using quantum theory, rather than Newtonian mechanics, as this focuses on the context of particle movement and therefore would allow introduction of such concepts as that an individual's behaviour will vary depending on the intensity and nature of disturbing influences, and that teaching requires stimulation of an individual to the extent that a change in behavioural state occurs.

Other examples of potentially useful theories from exotic fields are given in *Construction of Educational Theory Models*. The theory of local

and cosmopolitan influentials is applied to the institution-oriented and discipline-oriented professors. Information theory has been developed mainly in the context of communication theory, but it can also generate meaningful hypotheses in the educational setting.

The laws of chemical equilibrium suggest themselves as suitable educational theory models, particularly for educational administration, to which field we can now turn.

VII—The Use of Theory Models in Educational Administration

When considering the development of theory in educational administration, three facts appear to be of prime importance. First, administration is an eclectic applied field of study. Many propositions are gleaned from the social sciences and tested for their relevance in the study of administration. In this regard, the study of administration can be considered to be similar to the applied sciences of engineering and medicine which rely upon disciplines such as biology, chemistry, mathematics and physics. Second, a systematic theory of educational administration does not appear to exist. Third, the search for theory in educational administration has only occurred during the past twenty years, of which merely the last ten have been really fruitful.

Griffiths lists the adaptation of models from other disciplines as one of the four primary sources of administration theory.⁴¹ By 1959, only the Getzels-Guba social systems model, and Simon's decision model had been used from other disciplines as a source of educational administration theory, although this "borrowing" had occurred widely in other fields of administration. Most of the eight papers on educational administration surveyed by Elizabeth Maccia in 1962 used educational theory models of the representational empirical characterization type.

One such paper is that by Coladarci and Getzels in 1958 on "The Use of Theory in Educational Administration."⁴² They proposed a theory of administration as a social process, based on the work of Parsons, and perceived administration as a relationship between superordinate and subordinate which can be analyzed along authority, role and affectivity dimensions. Because the theory of administration as a social process is taken as a model and can be used to represent educational administration, the model can be classified, using Maccia's nomenclature, as representational and of the empirical characterization type. The empirical aspect of the classification is included because theories developed from the model would be concerned with the nature of the components as well as the relationships between them.

In 1958, Getzels proposed a theory model in his paper, "Education as a Social Process."⁴³ The theory model contained definitions of admini-

stration, social system, roles, etc., and a diagram, or two-dimensional model, showing the institutional (nomothetic) and individual (idiographic) dimensions of social behaviour. The model represents phenomena of administration, and can therefore be called a representational characterization model in Maccia's terminology: because hypotheses developed from it deal with the nature and structure of the components involved, it can be further classified as an empirical model.

Griffiths used systems theory as a non-representational model in "Some Assumptions Underlying the Use of Models in Research" in 1962.⁴⁴ He considered open and closed systems, and observed that open systems have properties which seem to characterize administrative performance. This non-representational characterization type is that considered by Maccia to offer the greatest potential for the development of educational theory.

In McClellan's paper, "Theory in Educational Administration," 1960, the model presented is a theory of educational administration as decision-making in situations resembling poker-playing in a group of friends and enemies, in which all must adjust to decisions made by the others if the group is to be maintained. "The administrative unit in education is defined as in a state of co-operative competition with a finite number of competitors." The unit tries to improve or maintain its position relevant to its competitors.⁴⁵

Using the theory of games requires that we can postulate that it is possible to rank preferred alternative outcomes for the next moves in the system: Maccia considers this model, that is, a theory of games developed into decision making, to be a representational model of the empirical characterization type. However, using her criteria, the theory of games itself appears to be a non-representational model when it is applied to situations which are not strictly "games."

Conclusion

The use of the term model in educational theory has become increasingly common, but conflicting and often unclarified uses of "model" have led to confusion and lack of understanding. There appears to have been sufficient "groundwork" performed on the uses and types of models, for "modelism" or "modelology" now to be placed on a more precise definitional base.

It is to be hoped that agreement on terminology is soon forthcoming, so that educational philosophers, practioners and research workers can freely and effectively communicate and co-operate in the development of educational theory to their mutual advantage. The lack of clarity in matters of terminology and classification seems to have resulted in models frequently being used to less than their full power.

In this paper, an attempt is made to collate some of the individual expressions encountered in the literature. Some of the inherent weaknesses, partly resulting from various types of definition, are recognized in this classification; however, it may serve as a starting point for a degree of conformity. It is suggested that whenever "model" is used in the social science literature, it should be modified by using the terms normative model, scale model, analogue model, and theoretical model, (and probably conceptual model), or any other similar terms about which consensus can be obtained. (The same problem of definition occurs in education with terms such as acceleration, curriculum, programme and streaming.)

In most instances, educational theory has been used as the model for educational events, that is, the theory model has been a characterization of educational phenomena. Maccia, Maccia and Jewett would appear to have made a major contribution by pointing out that at this stage of the development of educational theory, the non-representational model should be given priority over the representational model, which can then be used after more adequate educational theory has been developed. In any event, we can look forward to models becoming more helpful and more widely used, with the possibility that such apparently unrelated fields as pharmacogenetics and quantum theory may suggest testable propositions for education should be accepted.

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The authors of this article and their associates at The Ohio State University have, since 1961, carried out extensive investigations into the use of models to suggest and develop educational theories. In this article they show how a theory developed in another field can be used as a model for a tentative educational theory. Their illustrative example and comments thereon constitute a specific demonstration of the more general thesis advanced by Marc Belth. Their view differs significantly from his in that the analogical component is entirely absent.

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Educational Theorizing Through Models*

"... the greatest and most difficult problem to which man can devote himself is the problem of education."¹

We have devoted ourselves to such a problem. We want to get a solution—to "a true conception of the method of education."² The way, therefore, must provide for arrival at conceptions. Unless conceptions are forthcoming, how can their truth be evaluated? The main outlines of such a way have been drawn. Retroduction, a way of inquiring which devises conceptions and so is a help to the mind in producing science without defect, has been noted.³ Furthermore, retroduction has been given meaning in the context of models, points of view to be represented and so the source of conceptions.⁴ What remains, therefore, is the delimitation of the way in relation to our given problem.

Even though the problem has been stated as that of education, more needs to be said if the way is to be clear. What is wanted is an adequate

*The substance of this paper was originally presented in Publication 62-111, The Bureau of Educational Research and Services, The Ohio State University, 1962. Owing to circumstances which arose unexpectedly after the authors had contracted to prepare a paper for publication in this issue they were precluded from carrying out the necessary revisions. This task was undertaken by the editor with the knowledge of the authors. Some references have been deleted and minor changes have been made in the style and presentation but these do not alter the content to a significant degree.

educational theory or true conceptions or characterizations of the phenomena falling within the domain of the educative process. What phenomena fall within this domain? Surely what is involved are persons doing something within a certain kind of setting. Students, faculty, and other staff such as administrators are counted among the persons. The doing ranges from teaching-learning activities to budgetary ones. The certain kind of setting is a school within a community; that is to say, an interrelation of persons with persons and with physical objects.

Granted that what is sought is a theory to cover the entire domain of the educative process, nevertheless such theory is hard to come by. Consider that most educational theorizing which has been attempted is not of the comprehensive type. Rather educational theorizing falls within sub-categories depending upon the portion of the domain characterized. Theory of guidance relates to persons; curriculum theory, theory of teaching (methods) and learning theory relate to the heart of the something done, the teaching-learning activities; and administrative theory relates to the setting and some aspects of the something done.

It would appear at first sight that the educational scientist is simply a social scientist* of a special kind. After all, his concern is with individual and group human behaviour. What makes him a special kind of social scientist, of course, would be his interest in such behaviour within a certain kind of setting, the school. But careful examination reveals something more. His endeavour usually involves commitment to a certain kind or kinds of behaviour which are wanted. Rarely is it the case that the educational scientist is interested in simply characterizing the phenomena of the educative process. More often, he is interested in a characterization which includes an educational goal or goals. For example, when Guba turns to phenomena related to the curriculum, he becomes interested in a characterization which "is . . . capable of directing the child toward responsible behavior in the transactional sense here taken as appropriate in a democratic culture."⁵ An example from the popular genre would be the hue and cry directed at educationists to talk once more of the schools as places where "kids" are supposed to come to know. What it is to know is left vague and is argued about a great deal. Yet a characterization cannot be left vague, if it is to count as scientific. If goals are to be included in theory, then they must be given precision.

Now that where we want to get has been clarified, the question of the way is before us. As already indicated, the essence of the answer resides in retroduction, or the utilization of a point of view as a model for devising educational theory. To say more about the way, a considera-

*'Social scientist' is taken here in a very broad sense. The title refers to all scientists who seek for true characterizations of human behaviour.

tion of just such a devising undertaken for illustrative purposes should prove helpful.

Through a point of view from within the discipline of physiology, a theory of eye blinking, a conjecture or characterization of certain phenomena of the educative process, a theory of learning, was devised. The following table shows how the theory of eye blink is represented in the theory of learning, and thus is a devising model for it.

MODEL	EDUCATIONAL THEORY
1. Either the eyes are or are not covered by lids.	1. Either the student is distracted ("mind" is closed) or attentive ("mind" is opened).
2. Blinking functions to protect the eye from contact and to rest the retina and the ocular muscles.	2. Distraction functions to protect from mental stress and to rest from mental effort.
3. Blinking may be either reflexive or non-reflexive.	3. Distraction may be either non-voluntary or voluntary.
4. Reflex blinking may be due either to corneal contact (touch competing with sight) or dazzle (sudden and intense light) or menace (movement of an object toward the eye).	4. Non-voluntary distraction may be due either to competing or sudden or intense or threatening stimuli.
5. Reflex blinking may be inhibited by a fixation-object or by drugs.	5. Non-voluntary distraction may be inhibited by attention cues or by drugs.
6. Non-reflexive blinking may occur if seeing is unwanted.	6. Voluntary distraction may occur if learning is unwanted.
7. There is a normal blinking rate statable in blinks per second.	7. There is a normal distraction rate statable in distractions per unit time.
8. There is a normal black-out index statable as 100 times the ratio of duration of blink to interblink.	8. There is a normal non-receptive index statable as 100 times the ratio of duration of distraction to attention.
9. A normal blinking rate or black-out index do not significantly affect vision.	9. A normal distraction rate or non-receptive index do not significantly affect learning.
10. Blinking rate increases with physiological excitation.	10. Distraction rate increases with mental excitation.
11. An excessive blinking rate can significantly impair vision.	11. An excessive distraction rate can significantly impair learning.
12. Malfunctioning in relation to blinking may occur due to inability to keep eyes open (blepharospasm) or due to fatigue of the eye (fibrillary twitchings).	12. Malfunctioning in relation to distraction may occur due to inability to be attentive (certain neuroses and psychoses) or due to mental fatigue.
13. Sleep is a sustained blink, and so inhibits most seeing.	13. "Mental sleep" (may or may not be physiological sleep) is a sustained distraction, and so inhibits most learning.
14. Normal sleep is recuperative for normal vision.	14. Normal "mental sleep" (relaxation) is recuperative for normal learning.
15. Normal sleep is preceded by a sleep ritual which usually includes voluntary closure of the eyelids.	15. Normal "mental sleep" is preceded by a relaxation ritual.

Although the illustrative theory was highly tentative in nature, a preliminary survey of the literature indicated a surprising degree of relevance and fruitfulness. By 'relevance' is meant connection of the theory with other characterizations, and especially those which have checked out. By 'fruitfulness' is meant presentation, through the theory, of checkable characterizations beyond those we already have.

Turning first to relevance, Nichols⁶ reports concerning words which were found to distract listening audiences. He writes as if such stimuli induce non-voluntary distraction; however, his list of emotion-laden words suggests that threatening stimuli are learned, and so, at least initially, must involve voluntary distraction. Stopol⁷ employed failure stress as a distractor along with competing stimuli—bells, buzzers, and flashing lights; and his findings support the distinction between threatening and competing stimuli. He noted in his study that:

It therefore seems reasonable to believe that in the present study the introduction of a second stress stimulus increased the intensity of the stimulating state of affairs to a point resulting in greater loss of efficiency.⁸

Measures employing drugs and attention cues to inhibit distraction, as suggested by the theory, have been set forth by Daston⁹ and Foulds.¹⁰ Although no verification is set forth in his paper, Holmes¹¹ also emphasizes the importance of attention cues in relation to inhibition of distraction. Kingsley and Garry¹² speak of a form of distraction, day-dreaming, which might be considered voluntary. The attempts to measure attention span, which are apparent in the early studies on attention, fit in with the possibility of a normal distraction rate and non-receptive index which is set forth in the theory. Finally, the literature supports malfunctioning in relation to distraction arising from mental disturbance.

In regard to fruitfulness, the distinctions between competing, intense, sudden, and threatening stimuli suggested by the theory indicate an area of investigation into their effects and relative weight in developing distraction. In the research reviewed, the investigators assumed or ignored voluntary distraction. The theory hypothesizes that distraction may be induced voluntarily to shut out certain learnings. Attitudinal studies might shed some light on this aspect of distraction. Research on attention span appears to have overlooked the possibility of a normal rate of distraction and a normal non-receptive index which do not affect significantly an individual's learning. The measure of such a rate and index may have profound implications in regard to the teacher-student relationship and the media involved. The theory suggests that periods of relaxation are functionally related to learning, and this too has been suggested in the literature. Yet the theory opens up the possibility of a rigorous approach through rates and indices, rather than the usual rule-of-thumb approach. Undoubtedly more rigorous analysis would dis-

close many more possibilities; but the intent has been served, since fruitfulness has been shown.

What, then, does the illustrative devising tell us about the way? It is patent that at its very core the procedure is interdisciplinary. Within the discipline of education, what is wanted is adequate educational theory or true characterizations about the phenomena constituting the educative process. In a sense, what is sought is the making of education more of a discipline. The becoming of a discipline is becoming a body of knowledge, and a given body of knowledge is nothing other than adequate theory.* In the retroduction the discipline of physiology was used. That it is a discipline would not be contested, since it contains adequate theories about the functioning of living organisms. One of these theories, that of the eye blink, was used as a model to devise part of the discipline of education, a theory of learning. Surely betweenness of disciplines was involved.

Two difficulties, common to all interdisciplinary work, immediately present themselves. Between what and what—what disciplines are to be interrelated—is the first. The second concerns who—in the light of contemporary specialization, are the persons to carry out the work. In the context of the devising of educational theory through models, the first becomes what disciplines are to be marked off to explore for models, and the second becomes what qualifications are required of the theoreticians.

As a beginning point in the attempt to solve the first difficulty, a sorting out of the disciplines is necessary. Disciplines can be sorted into those forming part of the scientific endeavour and those which do not. The former are of interest, for the concern is with such an endeavour in education. The aim is the development of scientific educational theory or adequate characterizations about the phenomena of the educative process. Disciplines forming part of the scientific endeavour are the empirical and the formal. The empirical disciplines, as their title indicates, are about experience or phenomena. Depending upon whether they are about non-human or human phenomena, they are either natural sciences or social sciences. Within the natural sciences, two subcategories are apparent in terms of the non-living and the living, the physical and biological. However, within the social sciences, the subcategories are not at all clear. This vagueness could be an indicator of the fact that the social sciences are in an earlier state of becoming disciplines than

*Let it be noted that (1) no discipline is ever completely made, since no theory is ever completely adequate; and (2) unification is only an ideal, for it is the case that no discipline has a comprehensive theory, but rather consists of theories covering different aspects of the phenomena within its domain. One has but to consider physics which numbers among the disciplines having the most right to the appellation, 'discipline.'

are the natural sciences. It is only after development of characterizations that the domain of phenomena, objects they refer to, can be subdivided. Nevertheless, psychology and sociology do belong within the social sciences, as does education. The formal disciplines—logic and mathematics—are related to the scientific endeavour in so far as they provide ways of interrelating or structuring or forming characterizations about phenomena. Indeed they are crucial, since the natural and social sciences only become so when, among other things, they are systematic; when their concepts are structured with precision.

This sorting about of the disciplines has marked off three areas to explore for devising models for educational theory: the natural sciences, the social sciences, and the formal disciplines. Can anything more be said that would indicate one area as worth exploring more than the others? The quest is for devising models, points of view from which scientific theory about education can arise. This means that an area containing more theory of a scientific nature has more to offer in regard to scientific form and substance. The scientific theory is the point of view, and through representation of it the sought-after new scientific theory arises. In the illustrative devising, not only did the scientific theory of eye blink furnish scientific form that could be represented, but it also furnished scientific substance. Not only did it suggest the relating of distraction to stimuli, but it suggested the kinds of stimuli: competing, sudden, intense, and threatening. Without a doubt, citation is unnecessary to substantiate the claim that the natural sciences have more to offer in this respect than do the social sciences. Who would contest the claim that the natural sciences contain more adequate theory than do the social sciences? The formal disciplines too suffer a limitation. They offer only form to be represented, when suggestions of a substantive kind also are required.

Although we are faced with the paradox that the sciences dealing with phenomena the most divergent from those of education appear to have the most possibility in the realm of devising models, yet the other two areas ought not to be ignored. Besides offering some possibility for devising models, the social sciences might give us representational models, i.e., ready-made theories which when explicated might characterize (represent) educational phenomena. This would not be surprising, since education is a social science. Its phenomena are those of individual and group human behaviour. Besides offering some possibility for devising models, the formal disciplines might give us explicatory models, i.e., forms through which indefinite educational theory, which we have devised from another area or which we have taken over from another area, can be made definite.

Now that disciplines have been marked off for exploration, what of the second difficulty in regard to the nature of the explorers? It is patent

that the key persons involved in developing educational theory should know education. Their field of specialization should be education. They must know how far the discipline of education has come, so that it may be extended further. Yet it is this very extension and the way of doing it through other disciplines that requires more of them. Their competencies must extend into the disciplines being explored. If the natural sciences are explored for devising models, then some competency is required therein. However, this is still not enough. Dorwin Cartwright, in introducing a work on a mathematical model for the social sciences, tells us why and what more is wanted:

... but an individual social scientist can hardly aspire to master large areas of mathematics with the sheer hope that he may discover something which will be appropriate to his substantive problems.

Cooperation between social scientists and mathematicians is required to solve this problem. Specialists in these fields must work together in a way that permits the social scientist to learn what ideas mathematics has to offer him, without the necessity of his becoming a mathematician. Once a promising lead has been discovered, the social scientist may need to acquire a working knowledge of the relevant branch of mathematics. But even then it will be profitable for the mathematician to continue working with the social scientist because new mathematical problems will usually be generated by the attempt to make new applications of mathematics.¹³

Stated in the context of educational theory development, the competencies of the educational scientist do not extend far enough. Consequently, a counterpart, from whatever area the educational scientist is exploring for models, must be available to work with him.

The way of getting to adequate educational theory has been delimited in terms of its interdisciplinary qualities. Delimitation through educational disciplinary qualities still remains. This is required, for, even in the initial steps of the way of educational theorizing through models, the interdisciplinary phase in which the natural and social sciences and the formal disciplines are explored, an educational disciplinary phase must enter.

There is no completely *a priori* way of knowing whether a given theory from another discipline can be used to solve our problem, adequate educational theorizing or characterization of the phenomena of the educative process. We cannot completely know beforehand whether a given theory from another discipline can be used to devise educational theory, to explicate educational theory, or used as educational theory. Stated differently, there is no completely *a priori* way of knowing whether a given theory from another discipline is a devising or explicatory model for educational theory, or even a representational model of educational phenomena. Only educational theorizing or cognizance of other educational theorizing or in some cases both will provide the way of knowing.

In the case of devising and explicatory models, they are found to be such through educational theorizing. Educational theorizing is nothing other than developing characterizations about educational phenomena through devising and explicating such characterizations. In the illustrative devising a tentative theory of learning was set forth using the eye blink theory as a point of view. Through this setting forth it became known that the eye blink theory was a model for educational theory.

In regard to all the models, they are known in part to be such when the resulting theory is tentatively relevant to educational theory. Otherwise, the representational models would be models of something other than educational phenomena, and the devising and explicatory models would be models for sheer speculation rather than for educational theory. We must go to the literature on education, as was done in the case of the tentative learning theory, and tentatively determine whether the educational theory is coherent with other educational theory, particularly that which has proven adequate. Coherence can be noted in the power to summarize other educational theory. Indeed this is the kind of coherence one strives for in producing all science. Knowledge is a matter of integrating or bringing together. Scientists however, strive for something more. They are interested in extending knowledge. They will not settle for theory that is relevant only. It must be fruitful because "... it is now regarded by scientists as obvious that a good hypothesis may be expected to yield interesting new consequences".¹⁴ What we want are models for such good theory. To complete our knowing whether theory from other disciplines are models, the resulting theory must be tentatively appraised for fruitfulness. We must see whether there are new characterizations about educational phenomena, as was done in relation to the illustrative theory.

A final important aspect of the way, which has not been pointed out, should be noted. We have been speaking as if models are always found ready-made and never constructed. Consider once again Cartwright's advice that, although the lead has been discovered, the mathematician should stay on the job with the social scientist. He suggests that this advice be taken, because new mathematical problems may arise. What he is telling us is that the formal theory as is, may not be utilizable as a model. We may have to change it, and so construct what will be a model. Usually such construction will be called for.

The way we go from here is clear in terms of where we want to get. The methodology in terms of the problem is clear. The going remains. The first step in the task, the construction of educational theory models, now can be taken. The models that suggest educational theory models not only suggest theories but also, and more importantly, suggest directions for research. The theory of eye blinking set out above suggests a

theory of learning and indicates avenues for research which, if fruitful, will establish in part at least the validity of the suggested theory.

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Symposium

MODELS, THEORIES AND EDUCATION
A
THESIS, COUNTERTHESIS AND DISCUSSION

Contributions By

MARC BELTH—The City University of New York,
“The Study of Education as the Study of Models”

GORDON R. EASTWOOD—The University of Alberta,
“Uses of Models: Another Dimension”

JOHN MACDONALD—Sir George Williams College
“A Psychologist’s Response”

CHARLES J. BRAUNER—The University of British Columbia,
“Models, Models Everywhere”

Introduction

The papers published in this symposium were presented or are revised versions of papers presented, at the Third Annual Meeting of the Western Canadian Conference on Educational Foundations held at the University of Alberta during April, 1966. Their publication in this form can be justified on two grounds. In the first place there is currently a great deal of interest in, and discussion about, the value of models in educational research and in the quest for scientifically oriented educational theories. Much that is being said about models is loosely construed and consequently the term is being "mouthed" rather than meant in the strict sense. Secondly, the symposium discussion is typical of that level of academically desirable disputation which is essential to the rigorous examination of any field of enquiry but which is too much (many would argue) absent from the pages of journals devoted to the dissemination of facts, ideas and theories about the study and the practice of education.

Professor Marc Belth's keynote paper presented a view sufficiently controversial to encourage the group of subsequent contributors to bring forth some degree of support but a marked degree of counter thesis and academic conflict that enlivened the conference discussion and which, it is hoped, will now be transferred to a wider community of scholars in a wider range of educational enterprises. Throughout the conference the discussion was intense and persistent but never personal so that the contestants locked horns in combat on the conference floor but linked arms in friendship as soon as the conference curtain had been drawn. This is as it should be for if we are members of a community of scholars claiming to represent a discipline we must cultivate and exercise the ability to disagree in deadly earnest around the conference table but entertain no feelings of ill-will in personal relations. It is significant and very sobering to recall that Marc Belth was at one point at least, surprised to learn that some members of the audience had shown surprise when they witnessed his adjourning from the conference room to the dining room in friendly company with those who had so strongly criticised his thesis. Perhaps the attitude of these members of the audience gives point to the view advanced by Professor Macdonald that education may not yet be ready to be classified as a discipline.

In making the major contributions to the discussion available to a wider public the editor and his conference colleagues hope to inspire others to present their views for, against or parallel to those published. For the publication of future contributions the pages of this journal are open. Comprehensive and valid theories for the explanation of the many facets of the educative process will evolve in time. Their evolution can be facilitated by thorough examination of all views advanced and

by the development of the factual research on which they stand. The rise of the more scientifically oriented philosophy during this century has resulted in the transformation of the empiricism traditionally associated with English speaking philosophers to what is colloquially referred to as contemporary analytical philosophy. The close concern of these philosophies with the foundations of science and the nature of scientific research and knowledge has led to the development of a relationship between philosophy and research similar to, but even closer than that which existed during the era of Plato and Aristotle. Research journals can no longer concentrate solely upon the reporting of empirical studies and maintain realistic contact with the academic climate of scientists actively engaged in research. Those researchers (if there are any) who are not concerned with the isomorphisms that must exist between the observations and measurements they make and the entities they purport to observe and measure can produce only superficial studies.

The need for close attention to this isomorphism underlies the papers presented in this symposium by, particularly, Eastwood and Macdonald and to a lesser degree others. Brauner's paper is more fundamental in that he attempts to provide a logical model of the ontological frame of Professor Belth's thesis. All the papers are somewhat more abstract than those that have hitherto been typical of this journal but this does not render them less relevant to educational research nor does it make them less significant for the attention of practically oriented readers. That some will find the content difficult is not denied; that most will find it worthy of intense examination is hypothesized.

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The Study of Education as The Study of Models

I.

The clashes over the functions, directions, and inclusions of education reflect the clashes over the visions and accounts of our age. They are, like so many clashes among loyalists of different worlds, conflicts in which we deny the reality of everyone else's faith and evidence. Yet, there is something historically familiar in these clashes. It may be, as McLuhan has argued, that in coming through the mechanization of men into their individuation in the electronic age we have restored an ancient conflict, but given it modern dress.¹ The mechanization of society and of production and communication which dissolved face to face confrontation is now apparently finished, he has argued, and we find ourselves once again possessed of instruments which extend our powers and make possible new modes of direct confrontation. Space and time have been altered, moved away from the centre of our concerns, or eliminated altogether.

The restoration of this old clash, between commitment to the rational and commitment to the irrational does not give us any advantages in the effort to provide a resolution. The instruments by which the dilemmas have been created are themselves under attack. How shall we treat these new powers, and their effects? Can the new electronic instruments perform all our human functions? Are those functions which they cannot perform more or less important than those which they can? Are our intuitions which electrical instruments do not reproduce our last vestiges of primitivism? Or, are they the core of our human identity?

Depending upon the side to which you are loyal, education is a nurturing of intelligence by a transmission of knowledge and culture patterns, or it is an encounter within which are sensitized intuitions, compassions, awareness of self, to the point that everything we see in nature is ours, whether we can understand it, or explain it or not. Depending upon loyalties, therefore, we deride the irrational, or we hold desperately to the faith that beyond the rational lies man's great hope of grasping his own and nature's significance and identity, attained only by the thrust of his innermost being.

What is curious, however, is that for all this, for all of what appears to be a kind of ultimate conflict in print and in the disputes of scholars,

the educators still plod old familiar paths toward socializing children, even in the face of the fact that the society for which this takes place is dissolving. We still commit ourselves verbally to the transmission of knowledge, even as the most certain of our truths melt before the scrutinizing eye and mind. When we make alterations in our training or our teaching programmes we do so in the conviction that we are improving our tactics for preparing teachers, for more discriminate licensing, for more adequate distribution of the content of what is known. But we still find that the best place to become a teacher is in the school itself. It is an entrenched pusillanimity that sustains us as we continue to offer programmes, at the end of which the prepared teacher, in retrospect, so often denounces the programme which qualified him and hides from the conflicts of his age in either bitterness or the childhood of his charges. Few, and only somewhat later, come directly to confront the otherwise empty meanings of such terms as "socialization" and "transmission", to find out whatever intentions they may have originally contained. But this time, they do so in light of actual confrontation of experienced problems, alongside the learners the obligation for whose nurture he has accepted. But nothing communicates itself more quickly to him than the fact that the context for such a confrontation is alien to each teacher and each learner in a different way. And thus, both learn that education is, in the modern world, a non-natural activity.

But at least we recognize that the mounting conflicts in the claims of primacy between reason and passion is an assault on the notion of the old simplicities—of education as the mediator of culture, the determinant of behaviour so that when the child comes to maturity the behavioural patterns will be established within the range of tolerance and accomplishment in the given culture. Of course, to recognize the innocence of these notions is to shock education. It obliges us to make public that we really are more bound to faith in what we are doing, than to demonstrability or proof of what we announce as our accomplishments. It is to oblige ourselves to make public all of the gnawing problems we have long privately struggled against and to consider that the persistence of the problems created by the gaps between what we do in our work of preparing teachers, and what they themselves do in the active procedures of teaching might oblige us to suspend much of what we are about until we have studied more directly the meanings of the claims we make and the acts we undertake.

We find ourselves falling back on the more general, less definable claim that education is concerned to nurture the ability to think. But even here, the moment we have said this we find ourselves again in jeopardy. For we must recognize that the notion of the *act of thinking* is a metaphor, whose metaphoric form is lost through continuous pronouncement.

We usually reserve the term *act*, or *action*, for the operation of observable events. Flexing the biceps of the arms, playing a piano, and putting together the different shapes of a jigsaw puzzle are all acts. We can examine the processes of each of these and describe the separate movements of the complete event. But if we attempt to do the same for "the complete act of thought", we are attempting a metaphoric *tour-de-force*. In fact there is no possibility of producing a clear description and therefore no hope of resolution of conflicting claims.

Thus, our age pits a moot conception of reason against an over-extended vision of humane feelings, and the first casualty is the long-held conception of education as a function for which we can be prepared, and that its goals are transmission of knowledge, and of culture, and the alteration of behaviour. Such a casualty was neither intended nor expected, but it is there nevertheless. We must also recognize the consequences of losing sight of metaphoric concepts. The result is the loss of communion in an undertaking of the deepest significance for human beings.

1.

Yet treated metaphorically, that is, without being required to believe that we are laying bare at last the path that will finally lead us to actual observation of the act of thinking, we might be able to see a richer range of possibilities and a more promising identification of what we might continue to call the "act of thinking." The only way of treating what is not possibly observable is by the use of metaphor—analogy—model. The only people who would be disturbed by this are those who have come to treat science's metaphors as descriptions of a reality which will finally be encountered. Metaphor has no such function. Neither has it a non-natural reality, such as the power of being-as-such is said to have, so there can be no great delight for those who are led into acceptance of variations of traditional metaphysics. We are not about to describe the ultimately real, ultimately mysterious, though ultimately immaterial act of thinking, or of anything.

The use of metaphor is evidence of concern with the economic integration of ideas and experiences given the form of tokens or ikons, and culled from many sources at many levels. Analogies, which are cases of metaphors, make wholes of segmented experiences, experiences which are treated otherwise as self-contained entities of confrontation and which are accepted as they are immediately received, thus requiring nothing more to sustain their meanings and their significance. Metaphors are deliberate interweavings of separate skeins of experience which produce new images.

It must be understood that this description is itself metaphoric of either the process of weaving, or of architecture, by which be bring together stones to create an integrated, harmoniously constructed house. But what is clear is that within the metaphor the separate elements brought together find a power and a meaning which they could never have separately. This is the force of the metaphor, of the analogy. The power which is gained by putting together concepts which are normally not held together is vitiated, indeed made dangerous when we come to believe that the description is of something that will ultimately be observed. For we are led to look in nature for what could not possibly exist in nature.

Consider, as an example of both the power and the danger of metaphor, the term *cliche*. It is a now widely used, familiar English word. But it came to us from the French, where it means a picture taken from a photographic plate. It is not the positive, the actual representation, but the pattern from which the representation is produced. The metaphoric use of this term suddenly adds scope and insight to efforts to give an account and an evaluation of the way men often make assertions about themselves and others about their faiths, their faces and their aspirations. We make positives from the plates and the celluloid negatives which have been developed within us. We have a negative of a landscape, a nation's traits of character, and when stimulated by the proper chemicals, we give a faithful representation, not of what we have just observed, but of the negative which is put to work. (We will note later how similar this is to what happens in the use of mathematical models.)

The power given to an explanation of certain modes of assertions with the use of this term, *cliché*, metaphorically must be quite clear. The danger is probably no less evident. When we forget what is intended by the metaphor and consider the statement as an *actual* representation of what is now being observed, then we are claiming as true what could not possibly be proven. Not only is it obligatory for us to treat thinking metaphorically but, it will be observed, what we mean by thinking is the very activity of metaphorizing, or what comes to the same thing (but which will be explained more completely before we are done), constructing and using some model of events integrated for purposes of laying open to analysis features and relationships and powers of data, which they do not have in isolation, but which they seem to develop when brought together by the rules and forms we learn to accept.

The disciplines which constitute the world of scholarship are illustrations of types of metaphors and models which are given unitarily distinctive forms and types. Each identifies in human experience its own problems in terms of models unique, for the most part, to itself. Each type of problem is identified by the metaphors of the discipline which

are cast into a language which permits it to perform the functions it has set for itself. It would be an interesting study, had we more time, to set forth some of these distinctive metaphors, in order to observe too, the additional powers which become available when the metaphors of various disciplines are judiciously mixed. Even more interesting is the possibility of integration or unification of disciplines when their metaphoric character is identified.

Even when we run the danger of treating the metaphor as some actual substance, we can still make connection between the language which does not describe observables and the language which describes phenomena. Even when we are misled into believing that we are describing two types of existence, observable and non-observable, we are still developing a conceptual, or a linguistic network of connectives which enables us to move from event to event in the observable world without feeling the terror that between these events there are existing gaps. This is what enables the devout to feel the comfort of the unobservable, but existential force of God, or irrational power, or extrasensory perceptions and intuitions.

2.

The frequent use of the term *model* seems to suggest development of a new vogue. It may be nothing more than the eager use of a new catchphrase which seems harmless enough. But it may reveal a desire for a new mystique, a new awareness of a rich and fresh metaphysical reality, which would not be harmless at all. Both tendencies are always more or less distressing, for both block more insights than they make available. Moreover, it must be noted that however great the activity which ends with obscuring meaning by transformation in hopeless *cliché*, the term *model*, of itself, has no intrinsic quality, positive or negative. Whatever meaning it has, it derives from the context of its use. Therefore, so long as the context is rich in possibilities, the over-use of the term should not deter efforts toward developing a more precise, more illuminating meaning of the word.

The over-use reflects a familiar and indiscriminate assumption that the word is a literate, perhaps even technical, synonym for several other simple, less obscure, less mysterious, and more understandable terms. But, as I mean to use the term *model*, it is not intended as a synonym for the terms *structure*, *category*, *types*, *gestalt* or *method*. Whatever more specific definitions we have, these latter terms are used more vaguely to suggest some organized, systematized totality of events whose parts are definitely interrelated to the point that they are functions of one another. If we begin with this last as a projected, partial definition of model, then some interesting and important distinctions can be made between the term model, and its so-called synonyms.

Category usually refers to a classifying principle by means of which a series of events are sorted out and placed alongside one another in terms of the similarities each event shares with the others. Because of these similarities, we place events in the same *category*. Robins' eggs, the Lake at Annecy, sapphires, all belong in the category "blue".

Types refers to the characteristics within an event which makes it eligible for membership in a certain category. Thus, marble has properties such as its crystalline, veined structure, which make every piece of such stone eligible for membership in the *category* of stones which we call marbles.

Strictly speaking, *gestalt*, expanded from the technical terminology in the psychology of Wilhem Wundt, refers to the interdependent relationship of the parts which make up a given event, in which each part, by its presence and function, gives form not only to each of the other parts, but to the event as a whole. It is this wholeness of formal operation which makes us recognize that event. A shift in the function of any element within the whole affects the appearance of all of the other elements, and thus produces a different total appearance. By so doing it removes it from membership in one category and places it in another. Thus, for example, when a president who had been elected for a limited term of office is elected for life, the whole political gestalt shifts from membership in the political category called democracy to one identified as a form of dictatorship. (Interestingly, the very reverse of this has recently occurred in Indonesia, and the illustration becomes quite striking.)

The temptation to identify gestalt with model is especially great. Nevertheless, the difference, though disarmingly simple, is also very important. The gestalt refers to a concrete, or particularized set of substantive relationships, while the model is the conceptualized form by means of which the gestalt is explored, described, and explained. In this sense, the gestalt is the material which we examine by means of some model. In fact, it is a gestalt because some model has given it identity, and used it as an **explanatory event**.

Finally, *method* refers to the strategy of developing a consistency and effectiveness of relationships between the ends which are sought, and the means which are available, or which we need to bring into existence in order that the ends be accomplished. Again, the method is the strategy of operation for some model already accepted, or constructed anew.

Model differs from each of the other terms in the mode and intention of its operations, as well as the level of abstraction of its usage. In every case the specific functions and traits or properties which identify categories, types, methods and gestalts, will derive from what we will presently set forth as being the characteristics of models. Principally, the

model becomes the context within which categories, types, methods and gestalts are given form and meaning. But what makes for the confusion is the fact that any of the above terms can also be *cast into a model*. We can identify, for specific purposes, model types, model categories, model methods, model gestalts. But such a notation should make clear the distinction we are after. Types, categories, methods, gestalts, are all of them principles of action to be taken in experience upon the content of experience. Models are addressed to principles, not to raw experience, and what we are concerned with are the logical relationships which are projected as the characteristics of the different kinds of principles of distinction. In this sense, the study of models is heuristic. Its intention is to educate in the thinking made possible by the use of various examples of the various principles we apply to experience. The alternative is to absorb a given principle, a given method, or typology, or category of organization, and use it to the point of non-conscious effectiveness. In this way we are trained for the encounters in ourselves. A concern with models makes us aware of alternative principles by laying bare the structure of the principles we have learned to apply effectively and effortlessly.

Even when we construct a model which represents some observable event, say a space-capsule, an ocean liner, an airplane, we direct available categories of selection, methods of construction, types of materials, forms of objectives into the construction of those models which now embody all of these principles, enabling us to think about the world represented in that model. The model, as it is used, is the educational instrument the use of which is what is meant by the "thinking act".

By means of the specific and specifiable models we use the world takes on order, meaning, accountability, value and direction for us. Although anything that we encounter can be used *as* a model, nothing in and of itself is a model. Models, it is to be noted, are constructed for the purposes of enabling us to think about the world experienced. Where thinking is not involved, where we permit ourselves only to encounter the world, nothing in that world is a model.

3.

Not only are we dependent upon the specific models we have available for the detailed interpretations, explanations, descriptions and definition of the data we encounter, but the logic of our thinking, the range of expectations, the anticipation and acceptability of sequence and the determination of discontinuity are dependent upon the forms of the models we most frequently use. Most of us, for example, think in representative terms. The more literate among us find ourselves bound by analogical models and, as a result, seek out the relationships among

data and discover similarities which postivists refuse to accept. Their refusal only marks the tightness with which they are held by the idea of scale models in which features of events are sought out and compared. Surely, this must lie behind Wittgenstein's quest for similarities in what he termed "family resemblances". Families are recognized by the features which each member is said to have in common with all, or most of the others. A Bourbon lip, a Roman nose, the Nordic blond hair and blue eyes, the cowlick which all the male members of the family have, the complexion which identifies that family, that province, that nation.

The use of some model form occurs to most of us long before we are conscious of it. We change when with the development of our education we are made aware that other aspects of experience, and other ideas can become available to us, and we extend beyond the first model we inherit. But even this extension is not necessarily a conscious one. In the study of literature, for example, we are conscious of the content of the novels, plays and essays, to which we are introduced. The subtle shift from representative thinking to analogical thinking, or from analogical to representative, since there is no fixed order here, takes place below the level of conscious awareness. We are nurtured, without knowing it, to seek analogies between the relationships in the characters of this situation and the characters in some novel or play with which we have become familiar. We find ourselves richer for being able to see such similarities—but in fact what has happened is that we have employed a completely different form of model and have made discoveries not possible in any other form. We are now bound by a logic of relationships which was an impossibility in the earlier model.

Precisely the same thing occurs when we learn to use theoretical models, mathematical models, and linguistic models. Each model form we use directs attention to what the rules of the model form itself dictates. In using theoretical models we find ourselves constructing relationships between constructed elements or operations, and offering accounts of what can be observed by the use of posited descriptions and definitions of what cannot be observed. In doing so, we run up against the rejections of those whose exclusive use of scale or analogical models makes it impossible for them to treat such constructs as *real* entities, or mysteries accepted or absurd. For the same reason the positive thinker finds metaphor is deadly foolish and that theory is needless, since all theory must finally be concerned with predicting what in fact will be apparent, and verifiable in material or logical terms. Theory, treated as hypothesizing, or guessing, is something which is a dangerous and often misleading act, and is in fact, unnecessary. But the conception of theory as the mental act of positing a world of relationships which is not claimed to exist, and which therefore could not be proven or disproven, seems to make no sense at all to him. The most curious ex-

ample of the operations of models which dominate us, however, is to be found in the constant uses of analogy and theory by positivist scientists and linguists.

The analogical thinker is more readily persuaded to accept the theoretical form, because at least it makes possible a comparison between what is familiar and what is not in terms of the relationships confronted or sought. But he, too, gets lost when the insistence on the ultimate unobservability of the theoretical is emphasized. Like Hume, and Locke before him, he has accepted that although this particular, specific construct is not observable its simpler elements are. We know what gold is, and we know what mountain is: thus, although we admit there is no such thing as a golden mountain, we are not really dealing with unobservables. The notion that we are positing elements whose only existence is linguistic and that its applicability is simply a matter of familiarity, makes the analogist conclude that although we cannot see the atoms and the molecules of this table *now*, we will be able to as soon as we have invented instruments powerful enough to raise them to observability. So with God, so with virtue, so with faith. All these are sooner or later to be observed. And thus the claim that theory is a deliberate employment of ideas which bespeak non-observables falls hard. Perhaps it is this distinction between analogical and theoretical forms of models which might explain the supposed gulf between those educated in the Humanities and those educated in the Sciences. It certainly explains why so many have found that between the arts and the sciences there is the strong common bond of the creative act. But it makes more difficult the further explanation of why, from this common bond, two "cultures" develop, and the gap between grows into an unnegotiable canyon.

There is no need to go further at this point to explain what enters into the forms, and thus the uses, of the other models mentioned. Suffice to say that these forms impose the same characteristically different limitations on our accounts of experience as do the three already set forth. It is more important to point out other involvements. To study the limitations and the variations within each of these model forms is to study the limitations and the variations, the modes of elemental activities which enter into the activities of thinking, for it is clear that thinking is the act of applying some model form, whether we know we are doing so or not, to some experience. Thus, the study of the use of models is the study of thinking. If education is a matter of nurturing the ability to think then the equation of the title would appear vindicated. For the development of the use of those models in their variety is the act of educating, and thus the study of education is the study of the ways in which these models are constructed and nurtured as the intellectual power of human beings.

II

1.

I have argued that all models perform the same general functions, though they differ in the specific confrontations they make possible. I mean to offer a detailed exposition of one model form, hoping in this way to recommend the direction to be taken for a consideration, *mutatis mutandis*, of others for which space does not permit.

I shall concentrate on analogue models because most thinking about education has been analogical. To recommend the use of an analogy is to offer an answer to a question not always, or even often, made explicit. The question which arises is one of attempting to determine how best to set forth the problem or the disturbance which involves me at this moment. Suppose there are elements in a given dilemma which are familiar but more that are unfamiliar to me. How shall I think about the matter as a whole in order that the familiar will be extended to give an account of the unfamiliar? Suppose I were to think about *this*, as if it was like *that*, or *similar* to that? Suppose I think about education as if it was similar in its inner relationships to whatever it is I can find are the inner relationships involved in the transmission of knowledge. (I will stay with this conception of education, but I suggest that the same process would be followed had I said that education is analogous to the process of socializing the child, or of altering his behaviour to one of an acceptable, psychologically healthful form. But any one of these is, in fact, a prevailing analogue for educational thinking, though most would deny it was a mere analogy, and insist it is *actually* the transmitting of knowledge or the altering of behaviour, or the socialization of the child. The outcome is a curious, untouched dilemma of proving that an event carries its own name and definition, the problem which amused Plato in the *Cratylus*, and has occupied witty and dour philosophers right down to Russell, Wittgenstein and Carnap.)

But remembering that I am using analogy, whatever I am able to say about the procedures involved in the transmission of knowledge, I will also be able, because of the rules for the uses of analogue, to say about the procedures which comprise the processes of education. And yet, merely to accept the analogy, the metaphoric recommendation that there is an inner identity, produces at once the condition of jeopardy mentioned and the instrument for thinking about education. As to the jeopardy, the recommended analogy is so simple, so commonsensically appealing, that its metaphoric condition is lost almost as soon as it is pronounced. The weight of tradition here is so great that we are left asking, "But what else could education be except the transmission of knowledge, and those other activities which make it possible for the learner to put that know-

ledge to use in a healthful, acceptable way?" The tautology in the analogue model escapes us.

Nevertheless, if we are to think educationally, we must move from the familiar to the unfamiliar. By the use of analogy we move from what is very clear to what it is that can yet be said out of deduced comparisons. We will set out to explore in greater detail and more technical precision all that is involved in the transmission of knowledge (and in newly developing facets of this such as information retrieval, information storage, and so on). By analogy we will be able to make a definitive statement about a process which has always appeared so simple but has always evaded precise explanation.

Knowledge, we have come to accept, is the outcome of inquiry. We explore; we record; we identify perplexities; we note the "hang" of things; we observe how new elements alter the relationships of those things; we test the frequency of occurrences under controlled conditions; and when we are able to state a general conclusion, we have knowledge which pertains to the series of events which we have explored, tested, and demonstrated. Those conclusions are the knowledge which we transmit to the oncoming generation of learners. They are, collectively, our own explorations and solutions to the problems, and the explorations and solutions of others before us which have withstood additional tests in time and have remained warranted conclusions.

As knowledge is derived from this series of probings and reflections, tests and alterations, so education is a matter of getting the child to learn to perform those acts. But it must be the acts which have produced the knowledge recorded and warranted else we are not transmitting that knowledge into the future. And unless we do transmit that knowledge, it has been continuously argued, each generation would unhappily have to begin again at its very beginnings and every culture would have to be reborn in every new generation.

How very persuasive all this has been, and still is, not only about knowledge but about cultural projection and about the modification of behaviour so that such transmission and projections could occur and, in an expansive mood, about all three together.

But if we are truly engaged in analogical thinking can such claims be so definitively made? Have we remembered that we are embarked upon metaphoric analysis? If we do we will not make the error of saying that all of this *is* education, meaning it is all the spelled-out definition of education. But what has happened most often is that we forget we began with the *postulate* that we would think of education *as if* it were the process of transmitting knowledge. By elision *as if* becomes *is*, and the limits of analogy are lost. When we discover the limits later on (with-

out being aware that those limits were part of the model we used), we find ourselves adding other (also analogous) notions in aggregate form, leaving the first definition fixed. In this way the whole concept of education comes to have the inner relationships which are characteristic of a metropolis like New York or London. When particular needs develop, new segments are added until the whole event is so complex, so varied, so lacking in any integrated conception, that nothing definitive can ever be said—about New York or education—except that they are enormous and whatever you say about it is incomplete, wrong, or both.

2.

Now consider the character of analogical thinking and of analogues. First, analogies enable us to think about a problem in a way in which we could not otherwise do. That is, we can entertain it according to images or models otherwise not available. But we are holding one procession of relationships *as if* it were the other, not *as* the other.

Second, analogies refer to the internal relationships of those things, not to the features of objects. To claim an analogy is not to claim a demonstrable truth. Analogies are not limited to provable *descriptions*, but emphasize recommended explanations of the way things “hang” together. They depend on the fact that relationships could not, even in principle be observed. If they could, there would be no need for an analogy. Here lies the important limitation of analogy: that it represents nothing tangible.

Third, an analogue enables us to organize the raw data of inquiry in ways we could not otherwise do. If you hold knowledge to be a discovery of data already organized, then education is, by analogy, a matter of discovering the organized and meaningful data. But, the significant fact is that analogy is such that no event can be said to exhaust in properties and relationships another event. Analogy, therefore, requires the recognition of this additional limitation. At best it is recommendation for ways of thinking about an event, not a claim as to its actual identity.

In more recent technological or automated approaches education is considered analogous to information retrieval, and information retrieval is said to be a matter of discovering the *organization* of symbols and modulations within a context involving dictionary meanings of a given time and a given place. Whatever we discover about rules of pertinence in the ways in which information is stored in order that it shall be competently retrieved without significant loss of meaning and made responsive to the new demands of a newer situation, we will be able to say about the construction of curriculum for a given school at a given level

and about education as a whole. In this, as in an earlier example, the loss of sight of the metaphor produces a concept of education which horrifies the humanist.

Fourth, it becomes quite clear that the uses of analogy suggest the necessary limits of comparison which can be made between the functional relationships of any two events. This should be particularly evident in the matter of comparing events separated in time or in space. Thus, for example, when it is suggested that there is an isomorphic relationship between information retrieval and education we must mean (1) that the internal relationships within the whole of A is what is meant by internal relationships as these operate within the whole of B; or (2) only as an aspect of the inner relationship of A is best understood by considering it to be like discoverable relational functions to either a part, or the whole of B. If the first is intended, then we are close to a condition of logical absurdity, the absurdity of reductionism. What would be required to demonstrate the argument would take more energy than could be produced of worth by the use of analogy. The final outcome, if successful, would be to show that A is, after all, nothing more than B. And to do that for any two events separated by time and place, demands an abandonment of the data of both time and place, which seems to be an unwarranted loss of contact with the empirical world. So we are left with the alternative. Some aspect of the functioning of A is best thought about by analogizing it to a part, or the whole, of the more familiar internal relationships of B. But this, contrary to the first alternative, makes possible the fuller realization of the range of the differences between two events separated in time and in space. The dangers which analogy introduces—the dangers of reductionism, when so observed, are given a force of intellectual power, for they make possible the development of a whole series of analogies by means of which a complex field can be explored in detail throughout the range of its complexity but none which can claim to be a true picture of either educating or transmitting knowledge. These brief observations can be summarized into a series of logical statements about the character of analogy in thinking.

Analogies are but one form of those models, the application of the full range of which is here recommended as the full range of the act of thinking. An analogue is not a representation, nor a representative model of something, as a toy train is a scale representation of a genuine train. An analogue deals with relationships within two events which in actual appearance might be, in fact usually are, quite distinct. Therefore, it is only the functioning relationships of selected aspects of events which are said to be analogous. And thus, for an analogue to be illuminating, it must be remembered that the particular relationships addressed in two separate events are being seen in the explanatory system of one accepted set of relationships.

By analogy the most unexpected creations are wrought. This is of great importance, especially as we note that though the events confronted are observable, the relationships analogized are not. All we have are logical notations introduced for purposes of accounting for the sequences or the connectedness of things. Now, when we recognize that what we analogize has a logical rather than a psychological, and thus not overtly measureable character, we are a good deal freer to approach observed events in fresh and even unexpected ways. Ideas are, in a sense, more "mixable" than things. But even things are more malleable when approached with the instruments of fresh analogies. Nevertheless, though all analogies provide some conceptual benefits, not all analogies are worth their employment, as the grave danger of confusion and of misplacement must surely suggest. The gravest is the one already revealed in the misconception of education and transmission, beginning as an invitation to think of one event *as if* it were another, and ending, *ignoratio elenchi*, with accepting the features of the one as those of the other.

The problem, then, is determining some criteria for a judicious use of analogy. These must be developed out of awareness of the fact that the need for analogy, as the need for any model, is the need for providing explanation and interpretation of data, by developing a "fit" of this data and its original meanings into the new contexts and additional data. Analogy is a means of making old data pertinent to some new context, so that it can be made to stand forth with newly illuminated meaning.

Once free from the error of seeing education represented as the properties and characteristics of the knowledge gained from the already existing disciplines and from the concomitant error that the methods of each discipline are, identically, the methods of educating, we can make richer use of the analogical models we so frequently use. We can at least begin by suggesting that if, for example, history uses models to develop knowledge which must then be taken seriously, then education, by analogy, is a concern for the developing capacity to recognize, construct and use such models in any discipline at all. In such a case education is not identical with transmission, or socialization, but with the development of models by means of which both of these might occur. The analogy is with the operating relationships between data and ideas and not with the data and their functions as manifest in the lives of individuals.

In fact, in this sense, education would be best described as the activities whose objective it is to nurture a capacity for development and use of analogy and of other models which are necessary in the thinking

act. In this sense, too, education is no longer lost by reduction into so-called parent disciplines.

A final note is worth adding. In analogical models, as with all models, thinking is to begin with, deducing from the model what further might be described, discovered, explained, compared and then proceeding to the event to which the model is being applied. In this way each form of model directs us to a different dimension or quality of an experienced event and supplies us with the conceptual instruments for discovery, analysis, explanation or definition of that event. As I say—this occurs with *all* models, from the simplest representative to the most complex grammatical or mathematical. Our ability to make use of inductions depends upon the clarity of the deductions we have made from our models.

3.

Now let me move the discussion toward a direct confrontation of the study of models as the study of education. I must be conscious of the tentative character of the applicability of models in any discussion, in order to avoid enlistment in wars with nothing but disaster at stake—whoever wins. I will be concerned with what could be said fruitfully for the study of education in its own, non-derivative terms. In other words, how shall we think about education if it is to be given a character, a discipline status of its own, which it must have if it is to be studied in its own terms? For this reason we might well ask, is education conceivable as a discipline? Is anything added to human possibilities when it is so conceived? The answer must be of the character of the question. It depends upon the acts we identify as being exhaustive of the educative process.

Put it thus. To what shall we compare it? There's the problem. Further, in what *way* shall we compare it? That is a greater problem. Still more perplexing, how shall we determine that the comparison is apt?

To ask these questions is to be at least consistent with what has thus far been said of models. They have, of course, often been answered, though not often consciously. More often we have implicitly compared education to medicine, to psychology, to art. Inevitably, though we began with analogy, we ended with a comparison of the specific features of each, and finally came to notice that it has some properties but not others of art, of the practice of medicine, of the research strategies of sociology and psychology. Small wonder we could conclude that it has no features so distinctive to it that it could be identified as a undertaking of its own.

There was a time, not too long ago, when such a question of comparison was indeed a trivial one. It is no longer trivial for we have

come to understand how deep the consequences of such a question's answers might go in the formation of what is to be accounted as preciously human in the human being. But the significance of the question has only added to the frustration about it and about those who work in education, for the answers produced have revealed, apparently, that there is no exit from the indefinability of so mundane an act as the act of educating. Common sense has long been considered sufficient to support this. So, in order to escape from the mundanity, from the triviality which has accrued to the concept of education, we escape into the specialization of some already existing disciplines, and by combining several of them, persuade ourselves we have secured our efforts as worthy contributions to men and their societies.

But reconsider this. To what shall we compare "discipline"? To the properties of some set of activities in which observable events are discriminately, repeatedly and demonstrably examined and the results set down? Then discipline is equivalent to ostensive functions. In fact, all disciplines are a branch of the one discipline, physics.

Yet this does not have to be. There is nothing written in nature, or in men's minds, that can be read out as being the ultimate proof that this and this alone is what is meant by "discipline". We might compare it to an intentional act (again, the metaphor returns) of mentally aware manipulation of sets of relational terms and with the concomitant developing of a systematic context of rules of analysis and ascription, of reasoning and evaluating, in order to provide ourselves and our world with rules and controls for living. As there is increased precision and consistently expanding variety in our rules, so would there be a like increase in our potentialities for experiencing.

If we accept the first approach, then education cannot be shaped into a discipline, it probably cannot even be given any meaningful definition. The intermixture of model forms we use will not allow it. But if we work from the second approach, then we are concerned primarily, not exclusively, with active observation, experiment, reading out from nature its interior laws, but rather the control of the symbols of mental action of a particular concern, the construction of the system by means of which the experiments take place, the exploration or scrutiny of that system for its inner consistency, for its logic of relationships. If this sounds rather like a metadiscipline it is nevertheless quite respectable and there are many who hold that what goes on in the laboratory is not the discipline, but the practice. The discipline is a purely conceptual matter.

R. S. Peters, in his essay in Walton and Kuethe's *Discipline of Education*, begins with the assumption that education is a practice, as medicine is practice.² Now, since he holds that medicine as a practice is a

discipline only in the colloquial sense of being controlled, but is not itself a discipline, a set of rules itself, so does he also hold of education.

Clearly he is arguing here by an analogy, which has been widely acceptable to almost everyone. But he must take the model of an analogue seriously, and not treat the matter as if medicine were presented as representative of education. Not even Peters would want to hold that representative models are literal, and the elements which enter into the model are expected to give account of the event being modeled. But it is only an analogy to consider the practices of medicine, the treatment, identification and resolution of disease, as a paradigm for the practices of education. That would oblige us to see youth and ignorance also as diseases, and the labours of teaching as curative of those diseases. However delightful and clever the concept is, it is nevertheless only a metaphor to call youth a disease. To provoke a smile is not to prove a point.

But if we consider the analogue seriously we must look for relationships between elements of some larger entity not simply features of some limited action. In fact, the actions which mark the practice of medicine are not methodically fixed at all, and therefore even the claim that it is "controlled" is an ambiguous one. But, as an arena of action, medicine is a practice in which the principles, theories, definitions, descriptions and explanations of biology are applied to human processes. As a practice, medicine is at this time limited to the disciplined network of such concepts as define biology. As the newer disciplines of psychology and sociology grew up, biology, as a discipline, found itself both strengthened and limited. Its own definitions became more precise as other disciplines identified themselves. The medical practitioner no longer dares prescribe on what is now the basis of the findings of the psychiatrist, or the sociological inquirer. He simply recognizes that what he might have attempted to cure earlier more properly can be approached within the explanatory system of some other discipline.

One additional point. I am not sure that calling medicine *not* a discipline is very fruitful. In fact, it is a little too pat. The fact is that no one practices medicine without a deep grounding in the theories and accepted principles of inquiry and explanation of biology. It may be that not every biologist is a medical practitioner but can the reverse be true? I am arguing that any practice which is more than merely mechanical (and strictly speaking, even these) manifests, gives meaning to, and tests, in the discipline of which it is a part. The trouble with education is that we have operated on theories representing disciplines which teachers are not expected to become adept in—the disciplines of psychology and sociology.

Now, if we really use the analogy, we must establish some relationship between a parent system of theories, definitions, descriptions, rules

and explanations, and a flexible methodological application of the system in some practical situation. Thus, if the analogy is to have force, it becomes necessary to distinguish between education and the practices of schooling, which I have done in *Education as a Discipline*.³ If we are to seek an analogic source for analysis of education, we would go, with care, to biology, not with easy assurance, to medicine.

If this seems to return us to an old dilemma, of identifying the discipline of education as we do the discipline of biology by identifying its unique concern, we nevertheless have made room for answers in a way which we have not had available before. By separating the practices which are schooling we at least know that no analogy is to be drawn between education and any set of practices.

With what, then, shall we identify education, in the interests of that clarity which is the necessary condition for understanding our own endeavours in the experiences we undergo? We are now prepared to offer in answer, the familiar assertion, the "act of thinking". If we remember the wide agreement which prevails, that education is concerned to nurture the ability to think, we should have no difficulty in accepting the definitional suggestion, that educating is the concern with thinking in its many levels, its many types, its many forms of models.

If each discipline is concerned with the content which its models have formed out of the raw material of experience (as history, psychology, sociology and physics, for example, are identified by shapes they give to commonly experienced data, transforming it into its own subject matter), then education would be concerned with the forms (the media, to use McLuhan's notion) which carry its own meanings and make possible its own conceptual operations. To think theoretically, symbolically or grammatically is to think in given forms about the same data and to give that data different meanings, limitations, explanations, each time. This is what would become the subject matter of the study of education. It is the study of the forms which thinking has taken and might take and following each into its particular, or specific and concrete models, to see how they affect meanings of the data which they shape.

If the problem of the school's obligation for initiation, transmission of culture, the alteration of behaviour, the projection of knowledge, lingers to disturb you, remember that nothing we have identified as a discipline of education necessarily deters the actions of a classroom teacher who takes upon himself the obligations which the community or the nation imposes upon him. In fact, one thing has been added. For the first time, the educator, as member of a discipline, is now equipped with the developed or developing ability to evaluate the educational consequences of the social, psychological, economic, political and moral obligations which society imposes. For, as educator, his subject matter is the study

of the forms (and their consequences on the force and meaning of each) of the imposed social obligations.

And as every discipline does, a discipline of education would improve its condition as it constructs its own models of thinking. But in this case these are models for the exploration, description, explanation, definition, reasoning rules, inventions upon and evaluation of those models which proclaim the presence of some specific discipline which has laid open for human understanding and use some dimension of human experience.

Only remember this: "thought's behaviour" is a metaphor, and not an ostensive or a descriptive definition. Education, as the discipline which studies thought's behaviour, is not a counter-claimant to psychology, nor to philosophy. As it studies the consequences in human undertakings of "thought's behaviour", it is not seeking to displace sociology or ethics. It is not, to that degree, concerned with the overt consequences in the ways which psychology and ethics, sociology and history, are. It is concerned only with the conceptual range and depth of thought and the sensitivities to the world's qualities which the models available to us make possible for us. What the study of education alters, then, is not behaviour, but the models by which behaviour is understood, evaluated and enriched for the enrichment of human powers.

One result of this further analysis is that I am more than ever convinced of the fruitfulness of the original conception of thinking as a process within which all present disciplines are created, as I have elsewhere argued. Usually we have been persuaded that to think is to think about something. Therefore, to think is to think physically, or historically, or psychologically, and that a general statement about thinking is a generalization drawn from the particular acts of thinking. Thus, a general statement, or definition of thinking, is nominal only, a class identification which actually describes nothing.

But it appears now that what was implied in my original analysis can be made explicit, and, I trust, defensible. Thinking is an act that goes on about a great many events without being determined by those events. Just as light makes available information about many things simultaneously, so thinking depends, not on the data it confronts, but on the form which it gives to that data. That form is dependent upon what we have learned to do with the fundamental processes of organizing, analyzing, explaining, describing, interpreting our lives and our materials. To learn to draw analogies, for example, does not depend upon what you are analogizing, but on the form of analogue. Events in nature do not suggest to what they are analogous. To learn to represent does not depend upon the thing represented, but on the power to represent. If this applies to analogue, it applies no less to theorizing, mathematizing and linguistic analysis. We are deceived into thinking that a theory re-

fers only to an event, and therefore cannot be applied elsewhere. The theory shaped the event. Our trouble has always been the dread of abstractions. So we found ourselves limiting the theory to just that event in the name of factual clarity and limitation. But theorizing follows its own laws, as light follows its own laws. And just as light illuminates everything simultaneously, so theory is applicable to a wide range of data—to all data in fact, if we can but break through the atomizing or fragmentizing habit. Nowhere is this function more readily seen than in mathematical models, where a formula so obviously non-referential, can be applied to whatever there is at hand, however varied, however odd.

Out of all this comes the clear conclusion that the prevailing disciplines are the fragmentations of past social expectancies, and concepts of thinking, predicated on past notions of the limited function of physical events. Where thinking is conceived as model creating and operating, the present disciplines dissolve, to be replaced by whatever is distinctive in the *forms of models* alone. And what is now separately treated as, say biology, psychology, physics, astronomy or anthropology, might well be discovered to be variations of a totally different conception of discipline. Each of these present identities are collected data which reflect formal organizational and explanatory procedures, constructed within the study of the one, ultimate parent of all of the disciplines—Education. For it is Education alone which is concerned with the construction and nurture of the use of models by means of which thinking in its various forms, known and invented, can occur. This is what McLuhan has, in a very different way, argued too, in his final chapter, coming flush to the point on several occasions, without offering the specific grounds which are needed, if the argument is to be more than simple, though exciting speculation.

* * * * *

If we are truly, as H. G. Wells once wrote, all in a race between education and disaster, as the tensions in the world seem so completely to attest, then we have at least given a chance to education which it has not had before. For, in this great struggle, we discover, to our absolute horror, how often these claimed to be on the side of education turn out, in fact, to be on the side of disaster. For, the debates among the scholars all too frequently are more than the dialectical disputations which, it is hoped, will conclude with intellectual agreements to refined truths. They are the violent denunciations that this historian's findings, that sociologist's inquiries, the other psychologist's postulates, the opposing philosopher's analysis, are not history, or sociology, or psychology, or philosophy at all, but mystery, confusion, personal need, utter nonsense. Thus do we translate our models into the dogmas of the day. And in this

dogmatizing, nothing but disaster for the growth of intelligence, and for man himself, is promised. When education is seen as the concern for the character and the uses, the powers and limitations vested upon thinking, which are characteristic of the models necessary for thinking, then education is truly the alternative to disaster in human explorations. For no man's models dare be dismissed as worthless, just as no man himself dare be dismissed without firing the furnaces of destruction.

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Uses of Models: Another Dimension

According to Professor Belth "It is Education alone which is concerned with the construction and nurture of the use of models by means of which thinking in its various forms, known and to be invented can occur." I am, of course, not at all certain that he means that statement to be taken as literally as its form seems to suggest but I do not wish to attempt to refute, revise, or qualify it for him. I believe that Professor Brauner's analysis in this symposium shows effectively the logical structure of Professor Belth's view and the all-inclusive role for education that is implied. I will content myself by asserting that I cannot wholly agree with Professor Belth nor can I wholly agree that he does present a concept of model space as extensive as Professor Brauner contends. He does, however, present a view of the study of education as a discipline that is unique and different from the trivial views that are so often encountered.

In my conference response* to Professor Belth's paper I offered a number of criticisms and I take it as a compliment that his revised version submitted for inclusion in this symposium does not contain most of the things to which I objected. His revision necessitates my revision and consequently I have deleted *en toto* the section which made specific reference to Belth's paper. This leaves me free to concentrate upon two constructive tasks. Firstly, I want to say something about the logic and form of theoretical models and, secondly, to show how these may be used to describe and facilitate systematic enquiry. By doing these things I hope to give specific illustration of Professor Belth's general thesis and as well, to transform it to the context of scientific discovery. I believe that these are more worthwhile things to attempt than the discussion and/or criticism of Professor Belth's paper.

But, before I start on these I want to call attention to a general linguistic problem that is characteristic of much of the literature in our field. Every educator who introduces a new point of view advances a label word to designate it. These label words too frequently become emptied of real descriptive and referential meaning and achieve popu-

*MODELS and MEANING: *Proceedings of the Third Western Canadian Conference on Educational Foundations*, University of Alberta, April 18-19, 1966. (Publication Pending)

larity as metaphors, slogans or clichés. Dewey advanced 'growth', activity, 'continuity' and a host of others. More recently Bruner popularized "structure" and in doing so gave educational methodologists a pseudo-intellectual label for everything they want to do. Today, in some contexts, everything is discussed in terms of structure and, unless I am both mistaken and unperceptive, we will soon witness greater popularity for the word 'model'. It too may become a pseudo-intellectual label to designate anything or nothing and a candidate for inclusion in the lexicon of meaninglessness. This is a parenthetical remark and must be interpreted as such but it is too important to be dismissed. Educators must guard against the tendency to label and assume axiomatically that a *significant* relationship exists between the label and the referent.

In the literature of the philosophy of science the term 'model' is used in many ways and there is much debate regarding which are the appropriate ways. However, there is at least one factor or dimension about which there is, or until very recently, was agreement. I refer of course, to the use of model to refer to a replica, representation or schematization of the entity, domain or topic under consideration. When used in this sense a model is a simplified or logically schematized version of the object that is being studied. These take many forms, and have many uses ranging from the models used as toys and decorations to the minified and magnified models used for illustration, explanation and experimentation. It is worth noting that the design of educational institutions (the physical plant) could be facilitated if greater use was made of scale models. We seem always to build schools and *then* discover where are the congestion points that restrict the movement of students.

Statistical researchers are familiar with the use of mathematical models. The experimenter needs a model of his experimental design. This he can construct diagrammatically or mathematically but, for those who know the language, the latter is both simpler and more precise. For example, the analysis of variance model $\bar{X} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \epsilon$ is a great deal simpler than the equivalent verbal description or the corresponding diagram. In fact many designs cannot be represented diagrammatically in two-dimensional space. Like all mathematical models this one postulates a possible relationship but does not presuppose the existence of the relationship. Models are tentative descriptions or explanations designed to lead to understanding and, hopefully, to discoveries.

The examination of teaching-learning in the context of selling-buying presented by Scheffler is a typical example.¹ He uses selling-buying not as an analogy but as a model and attempts to show the points at which it describes the teaching-learning relationship and the points at which it fails to do so. Dewey used the biological-evolutionary model of growth to describe the educative process. The use of models in this

way has been prevalent in education and they have yielded inadequate descriptions and contributed to conceptual confusion because subsequent users assumed simple isomorphism that was not intended by the originators. In other words educators have tended to confuse explanatory and exploratory models with empirical descriptions.*

Although not truly analogical the models used by Scheffler and Dewey are partially analogical. They both attempt to achieve understanding of a domain by comparative reference to a known domain. The statistical model cited previously is non-analogical because μ , α and β refer to postulated sources of variability that are assumed to be components of the total variability of X. However, examination of a specific use of a statistical model reveals that the structure of the domain within which the hypothesis being tested occurs is determined by the way in which the researcher conceptualizes the domain. There are undoubtedly possible sources of variation other than those postulated by the two-dimensional system which the model asserts. Why do we assume that the variation among the members of a set of scores can be adequately and always reduced to variation due to occurrence in a particular row (α) and variation due to occurrence in a particular column (β) together with a general factor (μ) an interaction factor ($\alpha\beta$) and a correction to allow for inability to measure precisely (ϵ)? Models such as this are certainly useful but it is imperative that they be not allowed to assume the status of *the* model, and, even more important that they not be interpreted as *descriptions* of any *existent* state.

In the context of systematic enquiry at least, models are axiomatic systems which serve to delineate and limit the area of reference for which the hypotheses and speculations are applicable. Constructing a theoretical model necessarily implies selection of the operations, entities and relations which are, for the purposes of the particular research project to be considered relevant. No problem in the natural sciences, the social sciences or, in fact, in engineering, law, education or any applied field comes to us in manageable size or form. Understanding and enquiry both necessitate specification of a limited and manageable context within the total context. We cannot, for example, study personality *en toto*, but have to mark off from it some aspect or section for intensive examination. There is no limit to the number and forms of the aspects that may be marked off—the marking off process is arbitrary. One of the ways of doing this is by constructing models which *implicitly* define the aspect to be examined. This process is logical not empirical and certainly not analogical. Professor Belth asks me to accept that “we

*On this point the reader is advised to consider carefully the distinction between “model of” and “model for” presented by MacIver and Holdaway in their article in this issue.

paint, or weave, or chart, or construct" in order to explore, describe and explain our world. I agree but I insist that *what* we paint and *what* we weave are consistent with pre-determined models. I am suggesting that systematic enquiry can proceed effectively and advance the frontiers of knowledge if and only if we construct models by logical deduction from postulated entities that may or may not exist. I am also claiming that model constructing must proceed independent of all experience—of all analogies.

In view of this I am suggesting that while the statistical model concept is far superior to the types used by Scheffler and Dewey as a basis for generating possible explanations it is not, as generally conceived, sufficiently independent of experience to be fruitful. Both types assume isomorphism and both tend to be restricted by the isomorphic assumption. Because there are some points of similarity between buying-selling and teaching-learning we are inclined to accept that these similarities are significant. Because test scores can be arranged in rows and columns we assume that the consequent two dimensional model is adequate. The use in educational research of sampling designs such as the randomized block design assumes that groups of subjects (i.e., students) in different blocks vary due to interaction with their environment in the same way as blocks of plants in different parts of a field. The assumption may not be valid.

In the vocabularies of scientists and scientific philosophers the terms 'theory' and 'model' are sometimes used as synonyms but more frequently 'model' is used to designate any theoretical formulation other than a theory. A modified version of the latter is preferable and seems to have gained priority particularly in the social sciences. According to this version a model for a theory is an alternative interpretation of the calculus of which the theory is itself an interpretation. In fact in some cases which is the theory and which the model is a matter of choice.

Adoption of this version leads to a more sophisticated concept of isomorphism. A distinction needs to be made between simple isomorphic models examples of which are model trains, model airplanes and so on, in which the isomorphism may be, as May Brodbeck says, complete or incomplete, and theoretical isomorphism where the model is an alternative interpretation of a calculus. Generally, but by no means always, the interpretation which is considered the model is physically or schematically simpler. For example, use of fluid pressure in a U-tube as a model of electrical potential. This model may be, and often is treated as an analogy, and it is worthwhile noting that reliance on analogies as descriptive or explanatory devices frequently lead to conceptual confusion because isomorphism is assumed to be complete when it is only partial. This is, I suggest, what happened in the case of Dewey's "growth" model

and what happened with the "activity movement" in the era of so-called progressive education. After all, we do see the world which we *conceptualize* rather than the world that is.

The result is that we tend to believe that the world we see by relying on the ways we have learned to conceptualize it or the world we see because we rely on accepted theoretical systems such as the analysis of variance model is the world that is. The value of model construction by logical devices independent of experience lies in the possibility of conceiving other possible arrangements of the world. Acceptance of this, transfers enquiry from the context of observational discovery to the domain of substantiation through observation.

I would wish to stress the need to study thoroughly the ramifications for educational theory of theoretical models. In the process of systematic enquiry models "belong to the context of discovery rather than to that of validation."² Discoveries are not made by concentration upon those observables that our conceptual frames enable us to observe. The view that we "must move from the familiar to the unfamiliar" is a naïve and erroneous assumption that comforts those whose intellectual pursuits are circumscribed by conceptual frames that do not permit them to see beyond the world of particulars. This is a limitation that is imposed on all of us because we live in a world of particular sense-data and tend to forget that beyond it there may be a world of sensibilia.

The way out of this dilemma is to structure the process of enquiry as a process of invention rather than as a process of discovery. Discovery is, of course, the ultimate end and maximizing the possibility of discovering necessitates postulation of possible entities and relations. This brings me back to theoretical isomorphism. The conception of models as alternative interpretations of a calculus enables the construction of an indefinite number of possible models by logical deduction. In any context it is possible to observe, postulate or infer a set of entities or properties. The number of mathematical permutations and combinations of these entities coincides with the number of theoretical models (axiomatic systems) that can be constructed. The construction of these models is independent of prior or personal experience of the entities and therefore the models of thinking developed are free from the previously existent conceptual frames of reference of the investigator.

I cannot refrain from repeating that we do not proceed from the familiar to the unfamiliar—we postulate possible entities, deduce all possible models and from the consequent uninterpreted axiomatic systems attempt to derive testable hypotheses that may provide evidence to support the initial postulates. In other words, we invent the unfamiliar and utilize the familiar to test our inventions. Systematic enquiry is designed to transfer discovery from the realm of chance to the realm

of purposive endeavour. The enquirer does not wait for events to be observed and then try to describe or explain them. He constructs theoretical models which implicitly postulate previously unobserved events (events that have not even been previously conceived) and he directs attention to the search for instances of them.

I have been advancing a very brief description of contemporary scientific empiricism—a view that makes enquiry a philosophical problem and validation a scientific-practical concern. It is a view that avoids completely the so-called problem of induction because it transfers observation of particulars from the context of discovery to the context of justification. For this concept of the empirical basis of knowledge we are indebted to the so often maligned logical positivists of the Vienna Circle and their logical empiricist descendents.

SYSTEMATIC ENQUIRY MODEL

It is frequently asserted that research, investigation, thinking and cognate activities always and must start from or be initiated by awareness of a problem. However it can be argued that the problems we become aware of may not be the most significant problems and that a more useful form of investigation is one that generates or discovers problems by means unrelated, or only indirectly related, to the immediately apparent phenomena.

Systematic enquiry, the end product of which is explanation rather than the solution of specific problems, may be conceived as a four dimensional system. This system is a *general* model that provides the framework for the derivation of *specific* models from which testable hypotheses can be deduced. The four dimensions, are the, *referential*, the *theoretical*, the *experimental* and the *validational*. They are logically, but not necessarily existentially, distinct and their roles must be explained even though space permits only superficial explication. The *referential* domain is the total set of entities that constitutes the extension of the area in which enquiry is directed. These entities may be identifiable things, properties, qualities, relations, conditions, and other states of affairs or they may be inferred, hypothesized or postulated things that can be conceptualized or constructed by the experimenter or investigator. It is in fact important that the entities admitted to the domain be not limited to known, observed or observable states of affairs because only by such "openness" can the enquirer reach beyond the bounds of prior knowledge and prior experience of the area.

These entities or *referents* are each co-ordinated definitionally, by appropriate definitional forms, to signs or symbols, to constitute the vocabulary of the system. It is in terms of this vocabulary that subsequent operations are carried out and it is the significance of the re-

relationships between the terms of the vocabulary and the existential states to which they refer that constitutes the subject matter of enquiry.

The *theoretical* or hypotheses generating dimension or domain of the system functions wholly in terms of the primitive terms of the referent domain. But to these are added defined or derived terms formed by logical construction from them. This dimension lies wholly in the realm of pure theory because it embodies no concern with existential states. The conjunction, disjunction and negation of the primitive referent terms allows implicit definition of *possible* states of affairs which in turn are used to produce axioms. The more precisely these axioms are delineated the more precisely is the subsection of the referent domain demarcated for intensive enquiry. The axioms are only logically testable because their function is to define the specific research context. The combination of axioms produces general hypotheses which indicate possible states of affairs or relationships between the theoretical system and the existential world that it purports to explain.

The *experimental* dimension starts with the derivation of empirically testable hypotheses from the general hypotheses and culminates in experimental designs and experimental tests on the basis of which probability statements are made. The final stage of the experimental test is the rejection or the non-rejection of an hypothesis and the specification of the degree of probability that can be found for the assertion that there is an existential relationship between the theoretically conceived explanation and the observable state. Space does not allow for consideration of problems associated with the rejection or non-rejection of hypotheses but it must be noted that concern is with the entities of the referent domain rather than with the hypothesized conditions. In other words hypothesis testing leads to ontological rather than epistemological conclusions.

Although experiential (i.e., practical) tests can occur frequently in the experimental domain they are more prevalent and more necessary at the validation stage. The combination of sufficiently confirmed hypotheses produces descriptive or explanatory theories which can be tested and refined in experience—in practice. All explanations are tentative and all must be tested in practice. Coherence with other theories is the initial stage at which simplicity, consistency and significance are relevant criteria. But the real test and the real opportunity for refinement occurs when application to actual situations is attempted. The validation dimension of the enquiry model is concerned with this task. When an explanatory theory does not adequately explain phenomena under practically operable conditions it is time to re-examine the logic of the theory and the reliability of the evidence from which it was derived.

The schema which I have suggested rather than described in this very brief statement is four dimensional rather than of four level or four stage form. In practice no domain can be said to be temporally prior to any other even though the referential dimension is logically prior—perhaps to some degree temporally prior. The system is a theoretical model of the process of systematic enquiry viewed as a procedure which *implicitly* defines possible entities and relations and directs investigation toward their discovery. Its merit and advantage over the analogical approach to which Professor Belth subscribes lies in the degree to which it facilitates the efforts of the investigator to operate in a controlled situation but remain free from prior conceptions.

I readily agree with Professor Belth that we explore, describe and explain, in terms of (and circumscribed by) the conceptual models that we have learned to use. Wittgenstein asserted that “the limits of my language are the limits of my world,” and it is because of this that it is necessary to develop techniques that enable us to explore possible states of affairs rather than those that are already open to conscious observation. This consists of going beyond the facts in a much more fruitful way than by simply abstracting from known facts. Those who, while recognizing their value, dismiss too readily theoretical and mathematical models and concentrate upon analogies because “most thinking in education has been analogical” display a dangerous lack of scientific sophistication. They are led into saying that “mathematical models provide no possibility for developing hypotheses about the events of nature, nor of predicting what, in fact, can or might occur.” By so doing they disregard the facts of history for it was theoretical models that suggested the heliocentric theory of the solar system, the existence of unobserved planets, the theory of relativity, the theories of supply and demand in economics and a goodly proportion of the theories that currently guide in psychology, sociology and psychiatry. However, we must distinguish between the use of theoretical models as guides to enquiry and the use of analogical models as means by which the initial stage of understanding can be achieved.

If one is content to achieve only general understanding of the external world as it is *currently* conceived according to criteria *currently known* and *accepted*, the analogue will suffice. Analogies are oblique forms of simple inductive generalization. As such they can only create understanding of entities and relationships already known or assumed. If I enter a room and interpret a scene analogically I impose upon the interpretation a pre-conceived conceptual system and the process of description (or explanation) degenerates into confirmation of beliefs already held. The entities seen and the relationships among them are determined less by the contents than by the conceptual orientation of the observer.

I do not wish, nor does space permit me, to press the point any further. I am certain that I am not "knocking a straw man" but I am not certain that Professor Belth and I are basically opposed. I am certain that he is using the term model too loosely and too generally and that in doing so he is doing a disservice to himself and to the study of the discipline of education if in fact there is such a thing. His thesis that we can only see, interpret and describe the external world, or those aspects of it with which we are concerned, in terms of the conceptual systems we generate is a sound one but it is neither new nor unique. He fails, in part at least, because he appears not to realize that the type of models with which he is predominantly concerned are the types that impose on our thinking the restrictions which he wishes to avoid. The use of models to facilitate enquiry into the nature and role of education is one thing but to advance the theory that the study of the discipline of education is the study of the models we use to think about education is another. Perhaps John Macdonald is justified in asserting that more disservice than service may be done to education by premature attempts to justify its status as a discipline. Perhaps he is also right in suggesting that if educators want to hasten the development of their field as a discipline they can do a great deal by entering the empirical world. For my part I ask only that entry to the world of systematic empirical enquiry be typified by assiduous attention to the need for rigorous logical control of experiment and the consequent interpretations.

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A Psychologist's Response

Professor Belth's concern in this paper, as I see it, is less to explain his view of thinking (although he devotes considerable space to this) or to explain the meaning and relevance of models (although he does so at length) than to justify education as a unique and distinguishable field of theoretical interest. What he says can be summarized quite readily, even though the summary perhaps does not do justice to an elaborately structured argument. Thinking is model-using (and presumably model-building as well); thinking within a discipline is thinking in accordance with the models employed by that discipline; either education is not a discipline at all (that is to say, it borrows models from the accepted disciplines, and thus cannot be identified as a separate undertaking, or alternatively possesses only that systematization imposed by practice), or it overarches all the disciplines; (the first interpretation is manifestly wrong—incidentally, I think the argument is weaker here than in the rest of the paper—hence we are left with the second; and education is finally defined as a discipline of disciplines, which constructs models of thinking that illuminate the specific disciplinary models, and seeks an understanding of "thought's behaviour" (but approaches the empirical world only at its peril).

I suppose that I have been invited to participate in this symposium in order to represent psychology, and I shall fulfil that obligation by discussing Professor Belth's view of thinking; however, I also intend to comment on the definition of education offered in the paper.

I should say, to begin with, that the description of thinking which Professor Belth presents is, in essence at least, acceptable to many contemporary psychologists. That it would be endorsed by the cognitivists is obvious; and it would be tolerated by some of the more *avant-garde* neo-behaviourists. As one set of writers comments, dryly: "To psychologists who like alternatives to nickel-in-the-slot, stimulus-response conceptions of man . . . it is so reasonable to insert between the stimulus and the response a little wisdom."¹ And they are quite sure that a human being builds up "an internal representation, a model of the universe, a schema, a simulacrum, a cognitive map, an *image*." Bruner puts this point of view well: "To operate effectively in an environment, an organism must develop a model of the environment. The recurrent regularities and higher probability relationships are conserved in this model. Given such models it becomes possible for an organism to ex-

trapolate and interpolate on the basis of partial information, to perform the kind of inference that may be called "going beyond the information given." This is a task learned gradually at first and then, as the grammatical character of learning develops, it proceeds at an accelerated rate, as we convert masses of connected or associated events into more highly ordered systems."²

To think, then, to manipulate the environment and its probabilities coherently, is to have a model or, as I prefer to call it, an *image*; no doubt everyone has a different *image*, and no doubt a philosopher has a different *image* from a psychologist, and a psychologist from an historian (and if at this point someone should complain that the disciplinary and the personal models ought to be separated, then my answer is that I do not see how this is possible—being a philosopher or a psychologist or an historian is as much a matter of personal experience as getting married or having too much to drink or playing the slot machines (a person has only one "image" although he may have many "plans" . . .)).

So far, then, I am in agreement with Professor Belth. Now, however, I come to deal with what I consider to be some serious deficiencies in his treatment of thinking—deficiencies which may have consequences for his definition of education. These deficiencies have to do with the relationships between thinking and overt behaviour. If I may use Professor Belth's own language for a moment . . . the analogical model of man that seems to underlie this paper is that of spectator rather than participant. Much is said about "modelling," but little about the "planning" that connects thought and action. As Lewis says, and I agree: "The primary and pervasive significance of knowledge lies in its guidance of action: knowing is for the sake of doing . . . only an active being could have knowledge, and only such a being could assign values to anything beyond his own feelings. A creature which did not enter into the process of reality to alter in some part the future content of it could apprehend the world only in the sense of intuitive or aesthetic contemplation, and such contemplation would not possess the significance of knowledge but only that of enjoying or suffering."³ Professor Belth finds a special role for education as the study of "thought's behaviour"; but by "thought's behaviour" he seems to mean exclusively *modelling*, since he asserts that education should not be concerned with the overt consequences of thinking. My comment is that the acceptance of this role by the educationist would leave him lost in thought, which is just as unsatisfactory as being overwhelmed by passion or behaving at random. There is more to "thought's behaviour" than *modelling* and any description of thinking ought to take into account the links among knowledge, evaluation, and action. But, if Professor Belth were to move away from a complete identification of thinking with modelling, it would become very difficult for him to distinguish the task of education from that of

psychology, since, once a more differentiated view of thinking is adopted, the relevance of psychology to "thought's behaviour" becomes obvious (and is indeed belatedly recognized in the last paragraph of the paper).

It does not seem to me, then, that the role that Professor Belth assigns to education, however noble in conception, is a plausible one. I agree education is more than systematized practice; but I do not believe it is necessary to go to the lengths that Professor Belth does in order to authenticate education as a worthwhile academic endeavour. Nor are we at the point in the development of education as a field of theoretical study where it is possible to be so rigorous. Authentications are loose, and educationists are caught in an identity crisis; this uncomfortable situation will be with us for a long time, and we shall have to learn to tolerate it. The authentications we have are these: the best of the practitioners are anxious for theoretical substantiations (and the response will carry them further, eventually, than they expect or now wish to go); and the academics, the historians, sociologists, and psychologists, perhaps even, here and there, a philosopher or two, are becoming interested in education (to say nothing of physicists, chemists, mathematicians, etc.). Typically, if academics are interested in something, it becomes to other academics a legitimate object of academic study; this is an unsatisfactory substantiation, but it is likely to be as good as we can get.

The growing concern for theory in education will produce, initially at least, an interdisciplinary no-man's land, where the only unity is imposed by the organizational demands of universities and faculties or schools of education, or by the carefully planned and large-scale educational research which some of us hope will eventually be undertaken, as apart from simply being talked about. Out of this mish-mash a body of educational theory will, in time, make its appearance although at first it will be synoptic and derivative. If educationists wish to hasten the process, they can do a great deal by entering the empirical world and helping to foster the conditions which make possible this limping but inevitable development of education as an academic study. Premature closure, the establishment of a definition of education for which the field is not ready, may indeed have its special dangers. It may be suggested that one of the prime sources of anxiety is a state in which an organism's conception of the environment with which he must deal does not fit or predict that environment in a manner that makes action possible. If there is anything in this view of anxiety, then it follows that when one prevents an organism from monitoring the fittingness of his cognitive structures one is cutting him off from his principal source of adjustment.

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Models, Models Everywhere

In medicine, I am told, it is quite rare to find a classical case of some textbook diseases. The patient comes with so many contaminated and conflicting symptoms that the art of practical diagnosis extends quite beyond textbook and clinical training. It requires, as a matter of fact, that doctors ignore some of the most alarming symptoms and concentrate on some of the more subtle ones before they can classify the illness according to the models they have learned. The diagnosis is, indeed, quite unscientific, but once it is made the treatment is almost a matter of routine, in many cases. After examining Professor Belth's book and his paper, with the aid of some basic notes he supplied, I can see that the problem in medicine is not much different from the one we face in philosophy of education—a difficult analysis, followed by classification that permits a confident diagnosis. And even so, the outcome of treatment may be much the same in the two fields: the operation was successful but the patient died.

Introduction

One who has pondered the question of priorities, and come up with a different conclusion from Dr. Belth, is Goethe. In scene three of the first part of *Faust* we find:

'Tis written: "In the Beginning was the *Word*."
Here am I balked: who, now, can help afford?
The *Word*:—impossible so high to rate it;
And otherwise must I translate it,
If by the Spirit I am truly taught.
Then thus: "In the beginning was the *Thought*."
This first line let me weigh completely,
Lest my impatient pen proceed too fleetly.
Is it the *Thought* which works, creates indeed?
"In the beginning was the *Power*," I read.
Yet, as I write, a warning is suggested,
That I the sense may not have fairly tested.
The Spirit aids me: now I see the light!
"In the beginning was the *Act*," I write.

Professor Belth has considered the same chain of events and has, in the words of Anthony Crowe he cites at the close of his preface, chosen to move in the opposite direction when he writes, "What you seem to be saying instead of 'In the beginning was the word . . .' is that 'In the be-

ginning was the model'." As Goethe was no idle muse neither is Marc Belth idly musing when he says, "And so, I think, it must have been." These are his remarks in summary conclusion after considering the book as a whole with covers closed. At least, that is the way a preface is usually written, and, in my opinion, ought to be written. In these words he begins his own analysis, which I shall attempt to further. This analysis ends in a diagnosis that has a classical place in the diseases of philosophy. It may be called the fallacy of the unsupported universal. And, once understood, is treatable only by surgery. Unfortunately, in this case, it is surgery that cuts out the heart and leaves behind a corpse.

Analysis

Dr. Belth has no trouble telling us the kinds of things that models can be and the kinds of things that can be models. He writes in his book a model can be "... a word, a design, a plan, a picture."* This establishes models as part of the mechanical world of physical objects, events, and such. We can readily identify a word, a design, a plan or a picture and credit that some such do or could serve as models, that is patterns, maps, or diagrams for either imitation or interpretation. Hence, the meaning of models as maps, diagrams, or patterns of things and events is easily established and quite consistent with commonsense usage. And, to the extent that maps, patterns and diagrams aid thinking or lead to discovery, the notion that they might function as a guide, or theory, of sorts, is quite graspable. Thus, those that are called "scale models" set firmly on the ground floor of experience. But as the elevator goes up to the second floor (analogic models) and then to the third floor (theoretical models) a disturbing thing happens: the merchandise on the ground floor differs so markedly from that on the top floor that it is no longer clear how the term "model" is being used. Professor Belth adds up the ambiguities that result from his inability to define what he has catalogued under the term models when he writes of the summary contents of the model warehouse:

Models can be objects; they can be pictures; they can be verbal descriptions; they can be marks, abstractions, or line drawings. Models can be of single events or of relationships of whole universes. They can refer to objects in time and space; they can refer to laws which describe the sequence and order of events; they can be purely theoretic in their references, offering a model of concepts which could never be proven true or false. Sometimes an entire philosophical system functions as a model (91).

Rough sorted, then, things called models that range from objects to philosophic systems are arranged on floors from ground to top. But these

*Marc Belth, *Education as a Discipline* (Boston: Allyn and Bacon, 1965), p. 61. All subsequent references to this book are shown by the page numbers in parentheses in the text.

floors are also called models since the ground floor bears the marker—"scale models" and the top floor is named "theoretical models". But then the models which are objects or philosophic systems are arranged in special ways on the separate floors. What Dr. Belth is characterizing with this confusing system of notations is a concept of model space. We have the height in detail, now we need the other dimensions.

One is provided by such categories as mythical models, scientific models, historical models, and ideological models. Mythical models are shown to extend from such theological notions as Christian soul to the story of Isis and Osiris. All manner of superstition is supposed to operate in terms of a model "of the universe in which some objects have ascribed to them powers that they do not possess in any demonstrable way" (181).

The scientific models differ from mythical ones in that they are "constructs applicable to the observable processes of nature" from which "we are able to quantify the traits of reality for purposes of control and reconstruction" (182). Unfortunately, the only illustration given is Freud's "concept of the elements in the nature of man." One is prompted to ask what quantification and what observable process has ensued. But, for the moment, this can be allowed to pass as an illustration that the continuum of length that stretches from mythical to scientific may not admit of divisions.

Historical models can be analogical, theoretical, mathematical or representative we are told (183). As an example of one or the other Professor Belth remarks that Marx's model of history consisted of viewing "historical events, such as economic systems, religious beliefs, and societal relationships as having the same kind of natural causes as induce biological growth in an organism" (183). The undisclosed analogy is that such a view is the equivalent of a map and hence a model. The meaning of ideological models is given as follows:

Ideological models are collected and distilled sets of generalizations which may have been derived from some primary experience which may simply have been invented, but which are treated as the logical, but nevertheless true, parallels of the empirical world. . . . They are, in fact, the exposition of the fundamental orders of reality which escape the attention of ordinary men (183).

From context it seems likely that the "are in fact" can be replaced by "purport to be" or "are taken to be" so as to avoid accusations of an absolutism he goes out of his way to abjure (183). Since he states that it is untenable to assume a final reality picture, his effort to pass off his concept of model space as a universal leads him into internal contradiction.

Now that we have the characteristics of two dimensions, namely scale models, analogue models, mathematical models and theoretical models on the one hand, and mythical models, scientific models, historical models

and ideological models on the other, it remains to identify the third dimension so as to have a full characterization of the view of model space that Professor Belth is working from.

The clue to the third dimension comes in statements like this sprinkled throughout the book: "Each discipline is an organization of the elements of the act of thinking into some operational model" (173). These "operational models" which serve alternately as forms of inquiry, reasoning, methods, and as formalizations of ways of thinking will vary from department to department on any floor of the warehouse of model space as well as from floor to floor. There is, for example, "the dialogic model of Plato which does not, necessarily, involve as a presupposition a concept of complete and absolutely final truth; the scholastic model does" (190). This third dimension is of models of inquiry (194) and models of teaching insufficiently distinguished so they must be treated as one category inclusive of thinking acts, approaches to inquiry, and ways of teaching.

In addition to the dialectic model and the scholastic model, Belth examines the "nature model" in two aspects:

One is that nature is already formed and awaits discovery, exploration and description in order to become usable as a model. This conception gives rise to a 'copy' model for education. The other belief, more recent, less primitive, and much more intellectual, is that the basic premises for the understanding and control of nature do not lie in nature but are invented, and that the principles of invention lie in man's power for originality (195).

For simplicity, let's call the first the nature-representative model, as Dr. Belth does, and the second the "emergent nature model", omitting the copy model for teaching. From the emergent nature model, men as different as Rousseau, Dewey and A. S. Neil have built alternative models for teaching and learning (198-199). The book continues to enumerate this third dimension: "The experimental model holds that nature imposes no limits on the experiments to be conducted" (204). This turns out to be both an inquiry model and a teaching-learning model (205).

And, we are assured, there is a difference between methods and models within this third dimension of model space. "Methods, we showed, are matters of determining the proper relationship between means and ends and the pertinence of each to the other" (207).

Whereas: "Models themselves are not matters of means and ends. Models are the source from which ends are determined, or deduced" (207).

In summation of this third dimension of teaching-learning and inquiry models the book states:

We have used the dialogic model to demonstrate how a model affects the meaning and function to [sic] the elements of the educational act. . . . It is

easy to see how a scholastic model, a nature representation model and an experimental model might alter the meanings and the functions of the educative procedure and dictate the development of entirely different methods (211).

That this is a distinct and separate dimension of model space from that of scale, analogue, mathematical or theoretical on the one hand, or mythical, scientific, historical or ideological on the other, is established in the book when Dr. Belth writes:

The notion of the role of models in the direction of methods is important in that it identifies what Stephen Pepper has called the root-metaphors which give a logical force to the operation of the methods of each of the various disciplines (116).

Here then, in these three dimensions of model space plus the objects stored within it there is enough evidence of the different ways in which the term “model” is being used to begin classification.

Classification

Dr. Belth uses “model” in the following ways (and perhaps in many more):

1. To refer to some words, designs, plans, pictures, maps, verbal descriptions, masks, abstractions, line drawings, single events, relationships of whole universes, ideas, theories, concepts, theologies, or whole philosophic systems.

This is the *object referent* use of the word “model” by which any particular within model space could be designated the way items in a department store all could be referred to as merchandise. Virtually anything can be a model, though the book specifies only a few things that are and none that are not. These had best be labeled *object models*.

2. To refer to levels of abstraction at which some object models appear. Here he speaks of scale models, analogue models, mathematical models, and theoretical models. For simplicity of notation, these had better be called *model levels*.

It is never made clear when or how a particular concept, idea, theory, object, word, map or design ceases to function as an object model and begins to function as a theoretical model or analogue model. Nor is anything said about the possibility or consequence of it functioning in both ways at once.

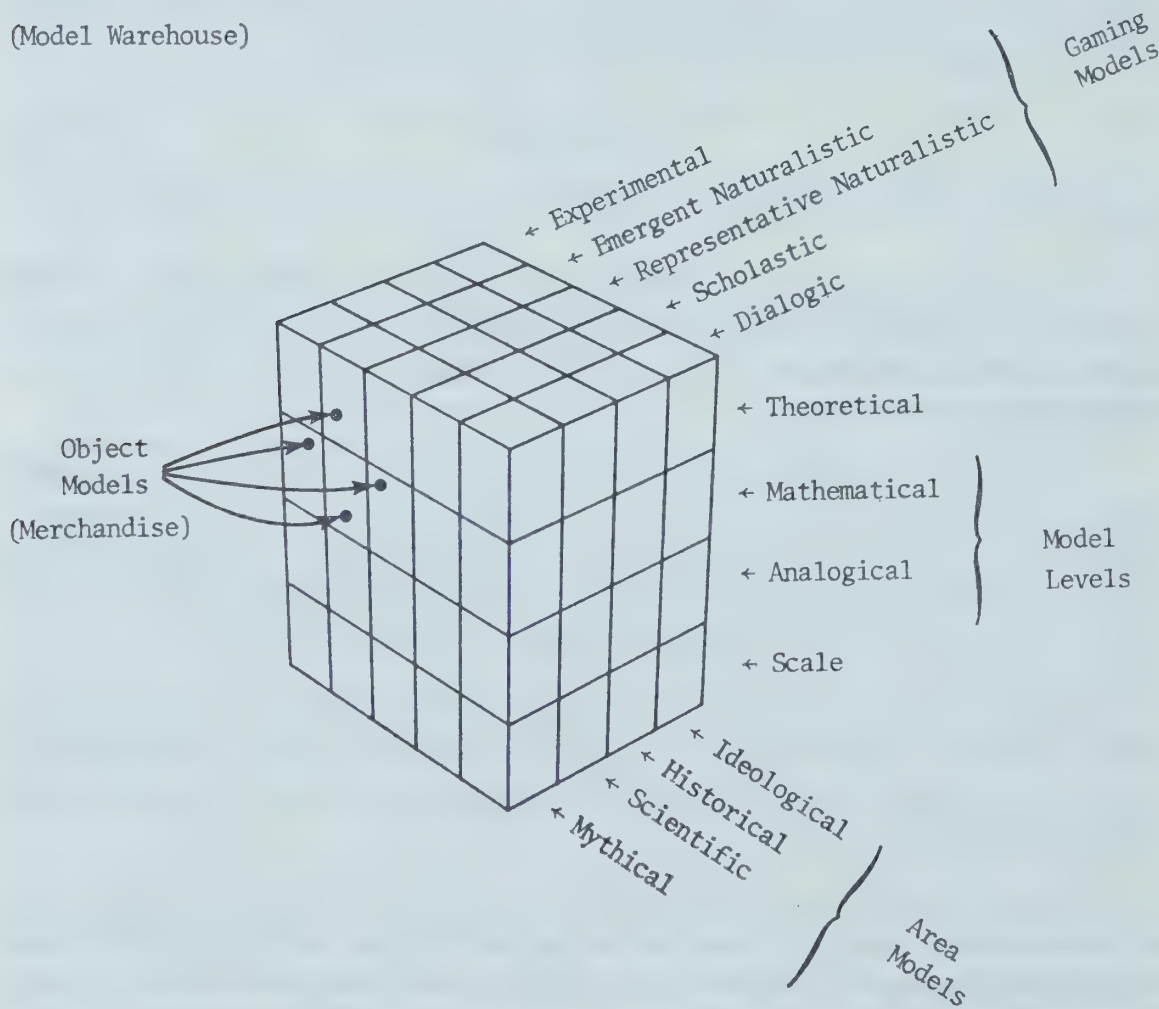
3. To refer to areas of activity at the different levels. Continuing to use the same term, undifferentiated, Professor Belth speaks of mythical models, scientific models, historical models, and ideological models. These can be called *area models*.

4. To refer to kinds of activities that go on within the different areas of the several levels. Here we find dialogic models, nature-represen-

tative models, nature-emergent models, scholastic models and experimental models. In addition, mechanical and pragmatic models are given, though pragmatic is used as a synonym for experimental. These, then, can be termed *gaming models*. They act as bases for viewing what rules might best be applied to the activities in areas called disciplines.

Thus, when Professor Belth refers to “model” or “models” without a qualifying adjective, or without an illustrative example, he could mean any or all, or any possible combination of all the possible positions in the following diagram of *model space* (or something else entirely).

DIAGRAM OF MODEL SPACE
(Model Warehouse)



This leaves some doubt as to what to make of a paragraph like this:

We have argued that the study of education is the study of the ways in which models for inquiry into the manifold experiences and concerns of men are constructed, used, altered and reconstructed. This includes developing skills in the use of prevailing models and becoming aware of the models which are available to us at any given moment. It also includes knowing the conditions which they make operable (263-264).

Diagnosis

What Professor Belth has done is to substitute the word "model" for "life" and restated the old saw that the study of education is the study of life in all its forms, real and imagined. Having found this much out by laborious analysis and classification, one disease can be named. It is jargonism. In its classic form, it consists of taking a technical term, abandoning the distinctions that give it meaning in special areas of investigation and using it as a substitute for a common-sense term so as to lend the air of scholarship to discussion without being restricted by any of the limitations that rigour would impose. It afflicts the naive as well as the corrupt, and renders discussion sterile. All this is to say that there is no conceivable way of figuring out what Professor Belth means when he uses the term model as the basis for building a discipline of education or anything else. He has carefully built a warehouse with four floors (scale, analogic, mathematical, and theoretic). He has designated the departments that might appear on any or all of the floors as mythical, scientific, historic and ideographic. He has specified the gaming activities that could govern bargaining in any department on any floor (dialogic, scholastic, representative-naturalistic, emergent-naturalistic, and experimental), and then stocked the shelves in each department on each floor with all kinds of merchandise. Having done this, he refers to all the merchandise as models, calls all the gaming regulations models, calls all the departments models, and refers to all the floors as models. In this way he provides himself with enough unspecified meanings of the term "model" so he can use it as he pleases wherever he wishes to refer to anything and everything in any way.

Yet there is more to the diagnosis if we examine the notes submitted as the basis for a paper. First, he offers: "Theory . . . is as much an instrument as the microscope or the truth-tables, or the multiplications table." Here we have an unconscious metaphor setting the stage for a cross-over between categories. But the game is a bit more complex than that. Remember, multiplication tables, microscopes and theories can also be models. Thus we have a term into which microscopes and theories can be telescoped as if the two were synonymous. This is the classical way in which the paramechanical hypothesis is built. Take a relatively well-understood term like body, explain its mechanics, and then take a mysterious term like mind and explain it according to the mechanics applicable to body. For the ghost in the machine hypothesis, a classic tale used to explain mind, "intelligence" serves well as the cross-over connection, since one foot can be planted firmly in the body camp as intelligent behaviour, and the other on the mental stage as intellect. But Professor Belth's use of the paramechanical hypothesis extends quite beyond merely using the mechanics of scale, analogue and mathematical models to suggest, but never define, the role of his general term "model"

in the development of a discipline of education. "Model" is Dr. Belth's ghost. Without ever stating it, he has built the term "model" from objective and specificable referents into a Platonic universal quite equivalent to the classic conception of Idea or Form. To do this, of course, he had to abandon all the adjectives that would give any special use of the term an identifiable position in model space. Ghosts cannot have observable properties. It is in the nature of a universal that it be beyond time and space. A clue to this use of the paramechanical hypothesis comes in the notes, where he writes in 2b: "But there remains the need to 'mention' or confront, inquire into, explore, the very theories which are employed, in order to determine the range of their applicability . . ." These meta-theories are themselves models for the examination of theories. But then there must be models for the examination of meta-theories. But then these meta-models must in turn be examined in terms of meta-meta-models. Ordinarily this infinite pregress from the mechanical to the metaphysical would trouble a philosopher. The likely reason it does not trouble Professor Belth is that he holds a view of the ultimate model to be a universal quite literally equivalent to Plato's concept of Form. Indeed, he tells us as much in the words of Anthony Crowe: "In the beginning was the model."

Briefly, Professor Belth's affliction is that he sees models everywhere the way some of the pagan devout may have seen gods everywhere. What he has done, quite unintentionally but not totally unawares, is to build a model monotheism and christen it *Education as a Discipline*. It must have been a stimulating exercise, but so far as I can understand it, not a helpful one. In fact, he has committed the error he set out to avoid. As is so common, when a patient is embarrassed before his doctor, he makes a correct diagnosis but attributes the affliction to others when he states:

When there is an unguarded mixing of model types and model forms, we find that we are victims of contradictions which reduce the world to a confused, disharmonious, inconsistent series of experiences. When models conflict, events seem either to have no bearing upon one another or to make no contribution to an understanding of experiences and men (184).

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MARC BELTH is Professor of the philosophy of education at Queen's College, City University of New York and author of *Education as a Discipline* (Allyn and Bacon Inc., 1965). His conception of the discipline of education as the study and development of the models we use to explore and explain the subject matter of education is a unique contribution to the field.

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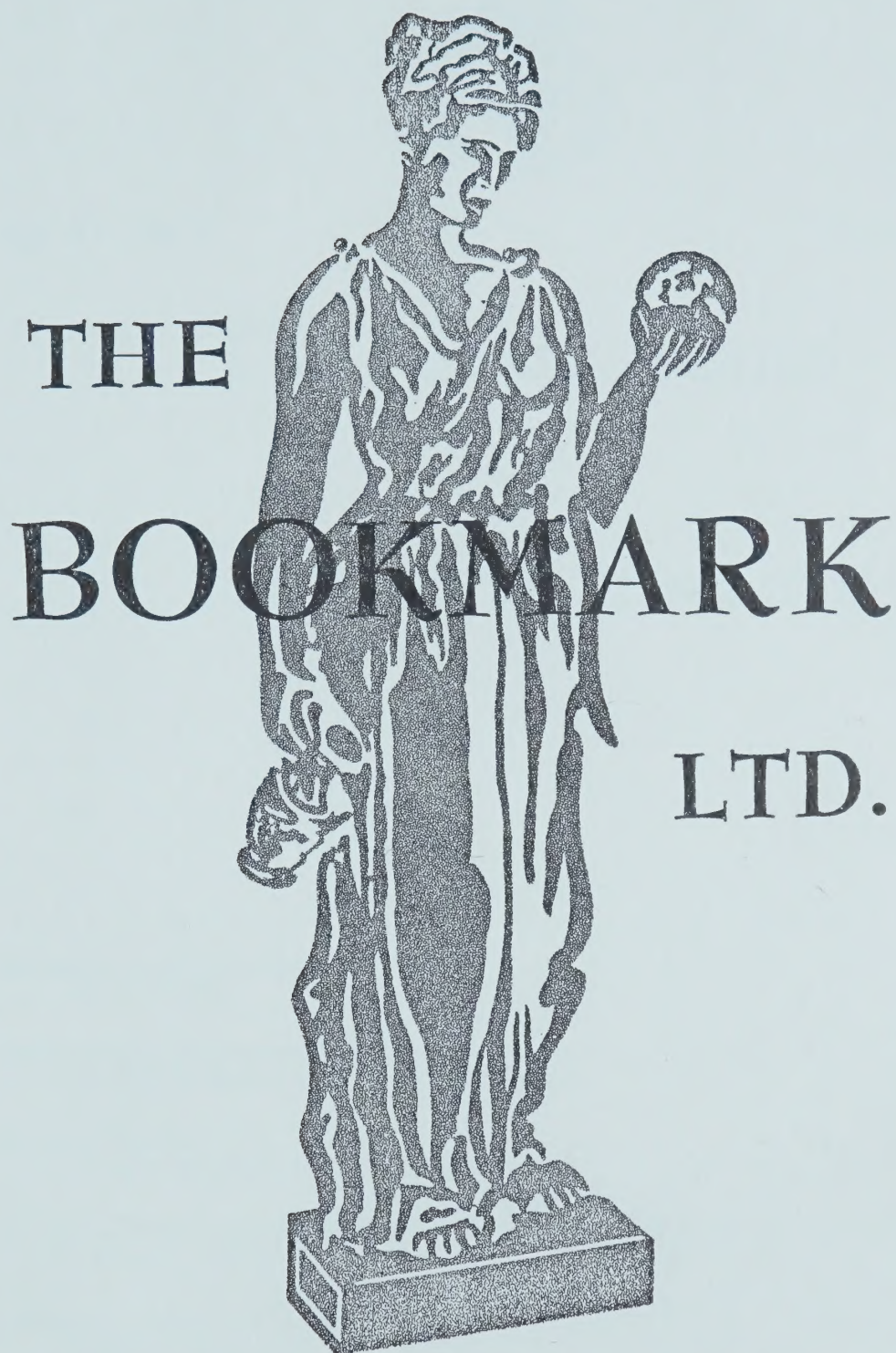
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